IRON AND STEEL ENGINEER

J. F. KELLY, Editor

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COMING MEETINGS AND PAPERS

PITTSBURGH SECTION

W. E. Miller, Chairman

R. B. Davenport, Vice Chairman
R. F. Chaffin, Past Chairman
A. A. Stewart, Papers
R. M. Hussey, Membership
T. E. Hughes, Meetings
J. S. Murray, Reception

Thursday, January 19th, 1928 (All Day Session)

Blue Room, William Penn Hotel — Pittsburgh. Pa.

TOPICAL DISCUSSION

"DOES GROUNDING THE NEUTRAL REDUCE APPARATUS TROUBLES."

10:00 A. M.

"The Theory of Grounding."
"The Effect of Grounded Neutral on the Efficiency of Lightning Protection Equipment."
"The Effect of Grounding on the Reliability of Relay Operation."

2:00 P. M.

"The Effect of Grounding on Telephone Interference."
"Experience with Equipment When Operating With Neutral Grounded."

Thursday, February 24th, 1928 (All Day Session)

Blue Room, William Penn Hotel — Pittsburgh. Pa.

"TOPICAL DISCUSSION COVERING INSULATORS."

10:00 A. M.

"Mechanical Design." "Protection from Flashover." "Overhead Ground Wires."

2:00 P. M.

"Effect of Dirt on High Voltage Insulators." "Insulator Hardware."
"Application of Insulators."
"Exhibit of High Tension Insulators by Various Manufacturers."

PHILADELPHIA SECTION

George J. Walz, Chairman — **Saturday, January 7th, 1928** — Linn O. Morrow, Secretary

SWITCHBOARD SYMPOSIUM

"Superpower and Its Effect on Existing Equipment," P. T. Vanderwaart, Electrical Engineer, New Jersey Zinc Company, Palmerton, Pa.

(1) "Obsolescence of Switchboard Equipment Due to Increased Service Capacity," by W. H. Andrew, Switchboard Engineer, Westinghouse Electric & Mfg. Company.

(2) "The Effect of Transient Phenomena on the Selection of Electrical Equipment," by E. G. Merrick of the Industrial Engineering Department of the General Electric Company, Schenectady, N. Y.

(3) "The Safety and Continuity of Service Angle," by E. O. Macfarren, Supt. of Substations, the Philadelphia Electric Company.

Engineers Club
Dinner 6:00 P. M.

1317 Spruce Street
Meeting 7:30 P. M.

BIRMINGHAM SECTION

J. E. Sayer, Chairman

A. L. Lemon, Meeting. E. C. Winfield, Papers. R. B. Gordon, Membership.

B. Thele, Secretary.

January 28, 1928—"Automatic Screw Downs," by G. E. Stoltz, Industrial Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

February 25, 1928—"Cold Rolling of Strip Steel," by H. C. Uhl, Assistant District Engineer, General Electric Co., Atlanta, Ga.

March 31, 1928—"The Invisible Relay in Vari Time Control," by W. H. Williams, Clark Controller Co., Cleveland, O.

CHICAGO SECTION

Edwin L. Upp, Chairman — Gordon Fox, Secretary

"Rupturing Capacity of Air Circuit Breakers," by E. Swift Newton, Cutter Electrical Co.

EDITORIALS

OPERATING INSURANCE

After a contractor has completed a new home, one of the first things the owner does before accepting the work and moving in is to secure protection on his investment against damage by fire. When this owner was arranging to finance this home, the bank probably asked that he take out a life insurance policy to protect the mortgage money. In addition to this, the owner, for the protection of himself and family likely possessed other policies as well as health and accident insurance. These common forms of protection are now rated as investments, for the owner and his family, in case of accident or sickness interfering with his earning power, or in case of fire. Year after year, this man will pay the premium on these policies, and receive no financial return. The fact that he is protected in case any of these things do happen is well worth his investments.

Perhaps this same man decides to purchase an automobile. One of his first thoughts is to get a standard make of car for which repair shops in his district carry spare parts and are able to repair. Thus he is looking for operating insurance. When he buys the car, it will have four brand new tires each guaranteed to run 10,000 miles, but for operating insurance, he will buy a fifth tire as a spare, and probably some blow out patches and a spare inner tube in addition. He buys these things before any of the four—10,000-mile guaranteed tires have been put in service—and his judgment is approved by practically every automobile owner. He does not buy a spare engine or battery because he knows that in case of either of these failing, he will be able, in some manner, to reach the repair shop where these spares are carried.

In the electrical operation of steel mills, the term "spares" has been used to apply to those extra parts and materials that are kept on hand to repair equipment when it fails. Due to the great number of different designs and types of equipment, these spares represent a large investment. Each year a record is taken of them, their money value estimated, and the total of the items placed in the plant inventory.

In recent years, the tendency has been to reduce inventories, and there are many good business reasons why this should be done. However, before those in charge of these reductions start applying their regular rules to the reduction of spares, they should first consult the Electrical Department. There is no more justice in eliminating a spare because it has not been used for a year than there is of discontinuing fire insurance because you never have had a fire; the spare bearings, armatures, or motors are there for protection just like the spare tire, and if we never need them, the investment may still be justified.

It would seem logical to classify these spares as operating insurance rather than part of the inventory. Each piece of electrical equipment bears a certain relation to the operation of the mill, and the mill in turn to the plant. There should be some method of calculating a value on continuous operation of these units in dollars per hour. The Electrical Department knows the probable delivery and costs of spare equipment, and whether or not they have to be purchased from the builder of the machine. In the case of coils, armatures, or motors, they know that there is a certain minimum delivery that cannot be shortened. In addition to this, their records will show the probabilities of breakdowns on various units. They can also show that the older the equipment the more likely it is to fail. Then, with all these facts, the amount of electrical operating insurance, to be carried could be determined. Some serious thought along these lines would produce values for continuous electrical operation, and a premium for electrical operating insurance set up. This premium would be invested in spare equipment.

If a method similar to the above can be applied to the "spares reduction," and to the purchase of spares, it would place the electrical departments in a more favorable position when the inventories are prepared.

NOT GOOD IF DETACHED*

You have frequently noted on your railway ticket a coupon marked "not good if detached," and a lecturer has used the phrase as the subject of an address in which he emphasizes the value of close attachment to high ideals, constructive work and service. The phrase is equally applicable in describing the professional man who endeavors to pursue his work unconnected with the organization which represents his field of activity. It would be no more accurate to say that all good chemists belong to the American Chemical Society than that all members of the American Chemical Society are good chemists. But we maintain that these unattached chemists, these non-members of the Society, however good in their daily work, would be better chemists if attached. Better because the support of their professional society indicates an attitude of mind which is always to be found in the well-rounded professional man; better because it indicates a desire to have a part in the advancement of the science and to do what they can to assist their professional body in reaching the ideal in service to the race, the nation, the professional group, and the individual. "Not good if detached." Think it over.

*From Industrial and Engineering Chemistry.

READING MEETING

About two hundred engineers representing the Steel Industry, Central Stations, Textile Industry, Railroads and Mines, attended the Annual Meeting of the Philadelphia Section, Association of Iron & Steel Electrical Engineers, held at Reading, Saturday, December 3rd, 1927.

Mr. W. M. Runyon, connected with the Crouse Hinds Company at Syracuse, New York, delivered a paper, subject, Electrical Safety Circuits—Their Uses and Construction. This paper is printed in

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Frequency Converter Speed Sets for the Carnegie Steel Company, Upper Union Works, Youngstown, Ohio

By G. P. WILSON*

IN the early part of 1925 the Carnegie Steel Company decided to electrify a number of their steam driven merchant mills in their Upper Union Works at Youngstown, Ohio. These mills roll a very large number of different merchant shapes and sizes. We understand that approximately 900 different products are rolled on the mills in these works. It was quite a problem, therefore, for their engineers to select the proper type of electrical drives for mills having such a variety of schedules. In general, it was agreed that some form of adjustable speed drive would be essential if increased tonnage was to be expected. Originally it was contemplated to use equipment having a speed range of approximately 40% and a large number of speed steps. This seemed to be the natural thing to do considering the nature of the product produced by these mills. But, due to economy and space available for the location of the equipment their engineers could not justify this type of equipment. Therefore, it was abandoned and a further check was made by the engineers into the rolling conditions, and it was found that a great number of products could be rolled at the same speed without seriously handicapping production. Also that the speed range could be reduced with but little adverse results to the total tonnage output of the plant. With these facts before them their engineers saw the need of a simple adjustable speed motor, one having, if possible, only three steps; namely, base speed and one step above and below base speed. The size of the step above and below base speed was somewhat difficult to determine, due to the nature of the product rolled on the different mills and several ranges were considered; namely, 15, 12, 10, 7½ and 5%. It was decided finally that 10% would be the most suitable step with an intermediate step of 5% if such could be obtained without adding too many complications. It was on this basis that they finally purchased the equipment. The complete electrification is shown schematically in Fig. 1. The 10" hoop mill is driven by 1—1600 hp., 493 rpm., 3 phase, 60 cycle, 6600 volt, constant speed wound rotor induction motor. This motor is arranged with shaft extension for the addition of speed regulating equipment at some future date. The 10" bar mill is driven by 1—1600 hp., 493 rpm., 3 phase, 60 cycle, 6600 volt, wound rotor induction motor with speed regulating equipment for definite speeds of 5 and 10% above and below base speed.

The 12" bar mill is driven by a motor duplicate of the motor driving the 10" bar mill. The layout of this mill is very similar to the 10" bar mill. The 8" bar mill is driven by 1—700 hp., 493 rpm., 3 phase,

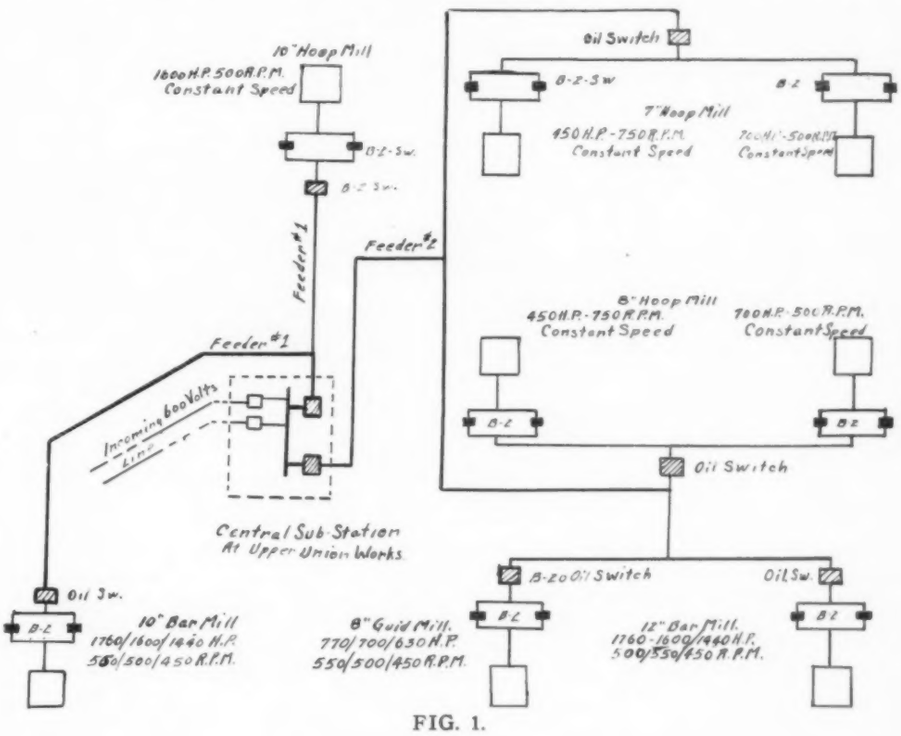

FIG. 1.

60 cycle, 6600 volt, wound rotor induction motor with speed regulating equipment for definite speeds of 5 and 10% above and below base speed.

The 7" hoop mill is equipped with two motors, 1—450 hp., 743 rpm. constant speed, 3 phase, 60 cycle, 6600 volt wound rotor induction motor driving roughing mill and 1—700 hp., 405 rpm. constant speed, 3 phase, 60 cycle, 6600 volt wound rotor induction motor with shaft extension for speed regulating equipment to be added later. This motor drives the finishing stands.

The 8" hoop mill is driven by a motor duplicate of the motors driving the 7" hoop mill.

The equipments are arranged with motor, slip rings and converter on a common bedplate and shaft.

The above brief description of the Mills and their drive gives you some idea of the complete installa-

*General Engineer, Westinghouse Electric and Manufacturing Company.

tion and will enable you to better understand the problems confronting the engineers when the proposition was first considered.

Simplicity and reliability of the equipment were the two all important points which the Carnegie Steel Company's engineers felt should be considered on this particular installation. To what extent they accomplish these important ideas will be explained by describing in detail the design and construction of the equipments furnished for the different drives.

The standard wound rotor induction motor is essentially a constant speed machine unless we use auxiliary apparatus in conjunction with it to change its speed. A number of methods may be used to do this, some of which are simple and efficient, others complicated and impractical. The most widely used methods are those that manipulate in some manner the secondary circuit of the motor. Several of these, no doubt are familiar, such as the Kramer system and the Scherbius sets. These two systems involve quite a bit of additional apparatus and, therefore, complications. A simpler method is that

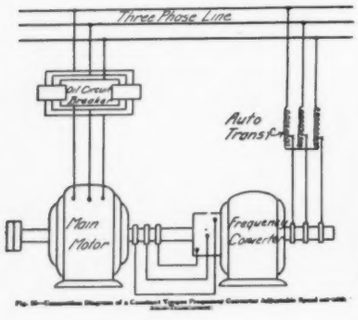

FIG. 2.

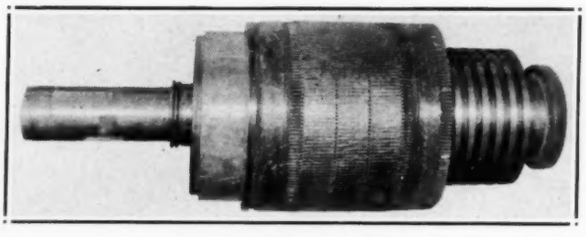

FIG. 3.

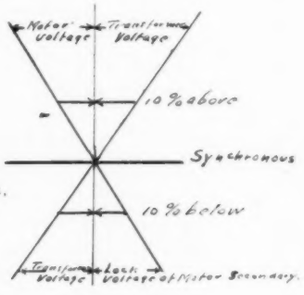

FIG. 4.

which is commonly known as the frequency converter type of speed regulating equipment, and as indicated in the above description, was used on this particular installation. Fig. 2 is a simplified schematic diagram of the apparatus furnished. As indicated in the diagram the set consisted of a main driving motor, a frequency converter mounted on the same shaft with the main motor and a transformer. Both ends of the secondary winding of the induction motor are brought out and connected to six slip rings.

The six slip rings of the converter are connected to the terminals of the transformer and the brushes are connected to the slip rings of the main motor. The high tension side of the transformer is connected to the primary source of power. The frequency converter, when the equipment is running below synchronism, takes the current from the main motor secondary at slip frequency, converts it into line frequency, and it returns to the line through the transformer. This condition is reversed when running above synchronism. The converter takes power from the line at line frequency, then the converter converts it into slip frequency and furnishes it to the motor. The converter develops no torque or any change in the voltage which passes through it. Fig. 3 is a photograph of the rotor. The construction of the rotor winding is similar in construction to the armature windings in a rotary converter, except that the commutator is equipped with three or a multiple of three sets of brushes for handling 3 phase current. The stator has no main winding such as found in induction motors, but is equipped with compensating winding. It is built up of laminated iron and acts only as a path for the field flux set up by the rotor.

The theoretical explanation of how the above equipment changes the speed of the motor may be briefly explained as follows. Suppose that the main motor is operating at synchronous speed. The frequency in the secondary under this condition will be zero and, therefore, the frequency on the commutator of the frequency converter will be zero. Under these conditions, the main motor is operating like a synchronous motor with D.C. in the rotor and the frequency changer is like a rotary converter with D.C. on the commutator and line frequency on the collector rings.

The motor if operating as described is exerting no torque. This, however, is only a theoretical condition. The no load condition, however, approximates it very closely inasmuch as the motor is only exerting torque sufficient to overcome friction and windage. Under this condition the current necessary to produce this torque is small, the resultant slip is small and the speed is, therefore, approximately synchronous. Now let us assume a definite load applied. At the instant the load is applied the motor is exerting only friction torque and it starts to slow down and continues to do so until sufficient torque is developed to overcome the load. The difference in speed between the rotor of the motor and the revolving magnetic field in its stator permits the coils in the rotor to cut the lines of the magnetic field and thereby generates a current, at a voltage and frequency depending upon the extent of the difference between the primary revolving field, the rotation of the rotor, the design of the machine and line frequency. This condition is shown very clearly in the familiar speed torque curve of an induction motor. The current generated in the rotor also produces a field, this field is in opposition to the primary field and is revolving in the opposite direction to the primary field and the rotor, at a speed equal to the frequency of the current generated in the rotor. Therefore, the rotor is revolving at a speed equal to the primary frequency minus the secondary frequency divided by the number of poles. The voltage generated in the secondary is in direct proportion to the drop in speed and the design of the machine.

Assuming that the design of the machine is such that the locked voltage of the motor at standstill is

1000 volts, then the voltage in the secondary at 90% of synchronous speed will be 10% of 1000 volts or 100 volts. It is obvious from the above that if we connect the secondary of the motor to an external source having a constant voltage of 100 volts at a frequency equal to the frequency in the motor, the motor will run at 10% below synchronous speed. It will continue to run at this speed until load is applied when it takes on a drooping characteristic the same as outlined above for synchronous speed. The cause for the drooping characteristic of speed is also the same as that outlined above.

Referring to Fig. 4 you will note that as we approach synchronous speed the voltage decreases until at the point of synchronism it drops to zero. If we reverse the direction of the applied voltage at this point so that it assists the voltage generated in the secondary, we reverse the direction of the rotating field setup by the current in the secondary and, therefore, reverse the secondary voltage. The applied voltage and the secondary voltage are now again in opposite direction, but not equal. Therefore, an increased amount of current flows and the motor speeds up until the two voltages are equal. Under this condition the relative speed of the rotor and the primary field has been changed from the condition below synchronism, so that the rotor is now traveling faster than the primary field. Therefore, it is cutting the lines, of force and generating in the secondary a current whose frequency will be equal to the difference in speed of the revolving primary field and the revolving speed of the rotor. The speed of the rotor will, therefore, be the line frequency plus the rotor frequency divided by the number of poles.

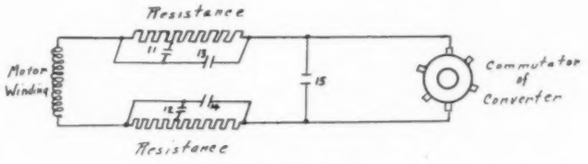

FIG. 5.

From the above description of operation it has, no doubt, become clear that the problem is not so much how to get variable speed from the induction motor, but how to get the external source of power for the motor rotor. A simple method of doing it would be by an A.C. generator driven by an adjustable speed D.C. motor. This method would be entirely satisfactory if it was not for the difficulty of holding the frequency of the two systems equal and of building machines for the low frequency required at near base speed of the main motor. A more suitable method, therefore, is by means of a combination of frequency converter and transformer. The transformer in this particular installation is provided with taps for 5 and 10% of motor locked voltage. The frequency converter as explained before does not vary the voltage of the power passing through it. It does, however, vary the frequency and this is accomplished in somewhat similar manner to the varying of the frequency in the rotor of the motor. The rotor of the frequency converter has normal frequency applied to its collector rings. Therefore, if it is driven at synchronous speed there is no relative displacement between the revolving magnetic field and the rotor. If, however, the rotor is driven faster or slower than the synchronous speed, the conductor in the rotor will generate a current having a frequency equal to the difference between the synchronous speed and the rotor speed. If the speed of the main motor is dropped to 90% of synchronous speed the rotor of the frequency converter is traveling at this speed, since the two machines are on the same shaft cutting this field, but the magnetic field is traveling at synchronous speed. Therefore, the frequency developed at the brushes of the converter is 10% of the main circuit frequency and equal to the slip frequency of the main motor.

The control for these sets is comparatively simple. As indicated in Fig. 2 the commutator of the frequency converter is connected to the slip rings of the induction motor and the slip rings of the converter are connected to the main line through a transformer. This transformer is wound so that by impressing the voltage produced by all the turns on the low voltage side on the sliprings of the frequency converter, the speed of the set will be approximately 10% above or below the normal speed of the induction motor depending on the direction of

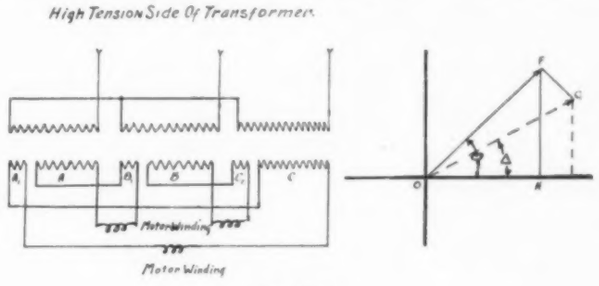

FIG. 6.

polarity of the impressed voltage. The transformer also has taps for 5% above and below normal speed of the induction motor. Thus the speed of the set may be changed by merely changing the taps on the transformer supplied with the regulating equipment.

You will note that a 3 pole double throw knife switch is furnished with the control for tap changing. There is also provided a double throw knife switch for reversing polarity of the transformer voltage so that the speed above and below normal speed of the induction motor may be obtained. The starting of the set is very similar to the starting of a standard wound rotor induction motor. The main forward breaker is closed by means of a master switch. The magnetic secondary contactors are brought in by current accelerating relays. An auxiliary contactor is provided under the knife switch which interlocks with contactors of the control so that when the motor reaches a speed of approximately 10% below synchronous speed the transfer is made from the resistance to the regulator equipment.

Fig. 5 is a simplified schematic diagram that shows the transfer scheme very clearly. You will note that after the transfer has been made that part of the resistance is still in the circuit. This limits the flow of current and cuts down the power peaks drawn by the motor. If the setup is such that the equipment is to operate at 10% below synchronous speed the remaining resistance is cutout very quickly without much increase in speed. If, however, the setup is such that equipment is to operate at 10%

above synchronous speed, the remaining resistance is cutout in steps at the proper time so as to limit the accelerating current to a satisfactory value and increase the motor speed smoothly.

A certain amount of power factor correction is accomplished with these sets. This power factor correction is obtained in this equipment by means of a small auxiliary winding in the transformer. The end of this winding is brought out and connected in series to a different phase. This changes the phase position of the applied voltage to the secondary of the motor, thereby correcting the power factor the desired amount. Fig. 6 shows diagrammatically the scheme and results accomplished.

The main windings are designated by A, B, C, auxiliary windings by A-1, B-1, C-1. The main windings and the auxiliary windings connected as indicated in the cketch will be at 120 degrees to each other. Therefore, the condition may be shown as follows: OH represents the kilowatts in winding A, of the kva. of this winding and Cosine of the angle ϕ the power factor. The kva. in the auxiliary winding B-1 is at 120 degrees to the KVA. of the A winding. Therefore, FG represents the KVA of the teriary winding and OG the resultant KVA and the Cosine of the angle delta the resultant power factor.

The speed regulation of these sets is approximately the same as an induction motor. The speed is affected primarily by the voltage in the secondary of the main motor. Hence, their speed change will be approximately the same from no load to full load as the main induction motor when running with its slip rings short circuited. This is shown very clearly in Fig. 5. With the voltage once fixed by means of the taps on the auto transformer there is no reason for its changing unless the primary voltage changes. Inasmuch as the primary voltage usually remains fairly constant it is natural to expect that the speed regulation will be approximately the same as when the motor is running at base speed.

The problems of commutation on these machines are very similar to those in any polyphase commutating machine. On 25 cycles with a reasonable speed range of 10 or 15% above and below base speed the design is simple and the commutation quite satisfactory. On 60 cycle and wider range machines satisfactory commutation is more difficult to obtain. The limiting feature on the design of these sets appears to be line frequency, speed and speed range. At a 10% speed range above and below base speed the converter is in physical dimensions about 1/3 the size of the main motor, while at 25% the converter is approximately 90 per cent of the size as the main motor. It is obvious that to exceed this range of 25% would be uneconomical. For this reason we seldom recommend these machines except for comparatively low speed range and for 25 cycle operation. In this field they have proven themselves very satisfactory, simple to operate and easy to maintain.

*The Public Service Corporation from the Larger Users' Standpoint**

By S. S. WALES†

THE production, sale and distribution of electric power under the Central Station system today, is a highly specialized business and is developing a commercial science of its own in addition to its purely engineering features. No one who has not made an exhaustive study of its different phases can speak with authority on the subject, so I will ask you to accept this paper, not as criticism but as a frank statement of what the title implies, the public service companies as they look from the user's end of the line.

I approach this subject from a rather unique angle, for in the Pittsburgh district, while we purchase 60,000,000 KWHr. per year, we also operate six large power stations, producing over 400,000,000 KWHr. per year with an inter-connecting and distributing system about twenty miles long, so we are producers as well as consumers, except that our power stations are not allowed to make a profit, which relieves us of the financial complications of sale and collections, to be met in the commercial production of power.

Dealing in the electric energy differs from the usual relationship of purchaser and seller, in that the central station does not sell a commodity but a service. The idea of selling a commodity was held to very tenaciously many years ago, when the companies interest ended at the more or less inaccurate meter.

About the time of the introduction of the Mazda lamp, the electric companies were brought face to face with the fact that they were selling light, as this development allowed the customer the same "foot-candles" of illumination at one-half the current consumption. The Power Station found itself with its light producing equipment practically doubled with no addition to their current generating equipment, but also the carrying capacity of its supply network 50% too large and its actual revenue cut in half.

To readjust the balance after this change, it was necessary to extend into new territory, or better to broaden the use of electricity in old territory, which seems to be the beginning of the era of selling "service" rather than current, which now dominates the policy of the large power companies.

This same attitude regarding service is also the controlling factor in nearly all dealing between the Central Stations and the large power users. There

*Presented before 20th Annual Convention, Pennsylvania Electric Association, Sept. 8th, 1927, Bedford Springs, Pa., and appearing November issue, Public Service Management.

†Chief Electrical Engineer, Carnegie Steel Co., Pittsburgh, Pa.

has been no such radical advance in motor efficiency as in lighting, and no such change can be looked for, as we have a very definite knowledge of what 100% efficiency is, in the transformation of electric energy into mechanical power, and no knowledge as to the same figures for light.

A radical change in equipment has been experienced by the industry, but it was in the direction of increased efficiency of production, rather than in use of power, when the steam turbine entered the field of prime movers, and the consequent concentration of large producing units in small physical space made possible the commercial production of large blocks of power.

The compensation to the company for the actual power furnished is the money payment they receive from the user, while the compensation for service rendered is the satisfaction of the purchaser, which takes a similar position as power factor correction in the technical operation of a station, in that it may not appear to contribute directly to the advantage of the power station, although its resultant will be more efficient operation of the system, and more business through better understanding of each other's problems.

In certain large industries there will always be waste or by-product fuels which it is economically necessary to use at the plant where they are produced, and others that can be transported reasonable distances. Up to the limit of these fuels some large power consumers will apparently be in competition with the Central Station, as their requirements allow the installation of equipment nearly as large and efficient as the Public Utilities, where as, the cost of production, with smaller and less efficient units may readily exceed the charge made by the Central Station for a more reliable service from purchased power. Beyond this point however, even large users of power, should make a very careful investigation, before assuming the burden of power station and purchased fuel as against a sub-station and purchased electric power.

Several investigations have been made under my observation which bear out this point, some covering plants where the load is concentrated at one point, and others where the delivery points are widely distributed, and in one case maintenance cost of transmission system alone out-weighed the saving made by a very low cost fuel, although the power bill runs into six figures for a year.

Some Central Station contracts appear to be written as if the customer was a potential enemy, and not actually the only means of the company's existence. I feel safe in saying that it is a very rare case in which the customer tries to evade payment of an equitable charge for either service or equipment installed, and it is highly possible that it would be better business policy, to charge such losses off, rather than write drastic clauses into a power contract, which practically constitute a threat to the customer, and which may introduce a discordant note at the beginning of their relations.

In case of an argument with a customer where the company discontinues service, there is no apparent justice in maintaining a demand charge when the company is admittedly not "ready to serve." Also if a few lights are required, where no special lighting circuit is available, it seems unreasonable to charge them at lighting rates per KWHr., on a low rate power bill, when no extra line or metering expense is incurred by the company, and they are not rendering light service. It would conversely be unreasonable for the customer to complain of poor voltage regulation on light so used. My view of these matters may be wrong, but it might pay to scrutinize some of the contract forms to at least see if they would be considered diplomatically worded if the position of the "customer" and the "company" were reversed.

While we are not concerned with rates in this discussion, mention should be made of demand charges, which although necessary in some form to protect the power plant, as now operated in connection with peak loads do not promote perfect harmony between the user and producer.

To the user it seems unreasonable that they should be penalized for a month by a demand based on a single 15 minute peak. Many times these peaks are established by necessity, sometimes by accident and often admittedly by carelessness. In the case of the last two, service can be rendered by the power company, in pointing out how such peaks can be avoided or reduced, which their wide experience well fits them to do, though they will often meet opposition from within the plant which their help would most benefit. In the majority of cases however, advances from the power company will be met half way, to the mutual advantage of both parties.

To cite specific methods of establishing unnecessary peaks, at one time I remember that we paid something over $300.00 due to a peak generated for the pleasure of proving to two electric locomtive operators, that one machine could push the other. In another case we paid over $2,000.00 increase on one month's bill for the pleasure of running a small plant "full" on purchased power when one of our own auxiliary units was off a short time for repairs.

My own experience, as a power producer, would indicate that entirely too much stress is laid on short time peaks, as they appear very infrequently at individual plants, and are subject to such an enormous diversity factor, that they have little or no detrimental effect on a power station of the present day proportions, and it would seem more equitable to make an extra charge for these excessive individual peaks rather than to extend the penalty over a period of 1 to 6 months as is the common practice. The present way of handling, makes an obviously unjust charge against the user, in the nature of punishment, and gives the producers a cash return far out of proportion to any strain on his equipment, or service rendered to the consumer. While I am not a lawyer, this appears to me like imposing a fine, which is a prerogative of the courts and not of a public service corporation.

Regarding the calculations required to determine the cost of power it would seem that a more uniform method might be developed. I realize that books have been written on this one subject and the more it is studied the less simple it becomes. However, I am in touch with purchased power from five large, successful and growing power companies, all with very divergent methods of calculating their charges, and yet when I applied all their rules to one individual case, the figures fell within a range of $.001 per KWHr.

Continuity of service is one of the chief requirements to be met by the public service companies, and one which they have brought up to a very high point, beyond which I feel that little more can be asked. They are, however, very much in the position of the automobile driver who gets complaints from the "back seat" when he hits a "bump," but can never get credit for the "bumps" he misses.

The present program of the inter-connection of large adjacent system, leads to greater safety and reliability of service from the customer's standpoint, as a very serious accident to one power house need not cause any interruption on the system usually fed locally by that station.

Several plants of a large steel company in the Pittsburgh District have been inter-connected for many years to gain this mutual support, and they would look very favorably on any plan of further inter-connection with the large power companies if it were not for the basic difference in frequency of the two systems.

In case of storm damage to transmission line, no individual customer could be prepared to put his system back in operating condition, with the speed and efficiency of the public service company, without carrying a line force far out of proportion to its normal needs. It is very seldom that any large per cent of a distribution network is seriously damaged at one time, although a considerable area in square miles may be affected, and the company by concentrating the normal line force for their whole system, as an emergency force for a comparatively small district, can restore the service in a remarkably short time.

My judgment of the value of a Public Service Company would be based on its personnel, organization, and ideals, fully as much as on its financial strength and aggregate equipment. The supply of power is so vital to all modern industry that a company assumes an enormous responsibility when it enters this field, a fact which is becoming more and more thoroughly appreciated by both the producer and the consumer of power. Every effort should be made from both sides to keep each other advised as to their problems, possible increase or decrease in use of current, shut-downs which will release a certain block of power on the consumer side, and repairs to station equipment that may make the more economical use of current, for a short time, an advantage to all.

The time is passed when producer and user can stand on opposite sides of the fence, and to get satisfactory results they must establish a connection with each other almost as close as that of the consuming motor with its supplying generator, where each may be able to respond instantly to the requirements of the other.

In our dealings with power companies we have almost uniformly found them willing to meet any reasonable suggestion or request more than half way.

Combustion Control For Industrial Furnaces*

F. J. RYAN†

UPON receiving the highly appreciated request of your society to prepare a paper upon the subject of Automatic Combustion and Temperature Control, I tried, as far as possible, to put myself in your shoes in order that I might determine what would be interesting and instructive.

The answer seemed to me to condense into the reason and the necessity for combustion and temperature control, its origin and a general summing up what it has so far accomplished. It is on this basis, therefore, that I have prepared this paper, and I trust that the lack of elaborate and specific data on individual installations will not be disappointing, and to those who have a mind to go farther into research of the subject, our files which contain a record of installations of equipment of both the Ryan and competitive types, are open for inspection.

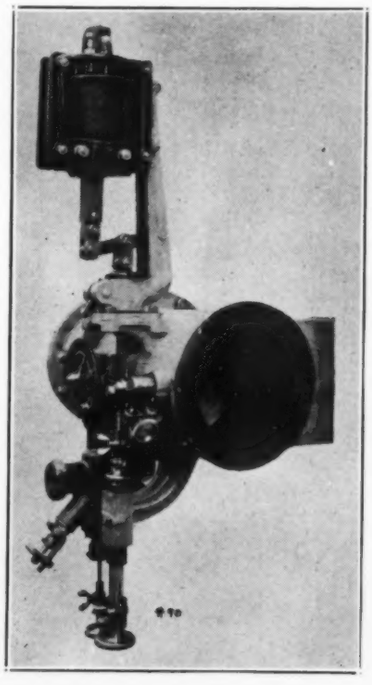

FIG. 1—Typical air and oil valve group.

My personal experience in industrial heat treating commenced with the electric furnace in its very earliest days—days when the electric furnace was considered a luxury. However, the rapidity of its adoption quickly erased this misnomer, for to the electric furnace more than any other vehicle in the industrial heating field, do we owe the proof in showing the fallacy of the belief that B.T.U. cost was the governing factor of ultimate cost.

I could tell you many interesting stories about the origin and the early selling of the electric furnace idea to industry, but they belong to another picture. It is sufficient reason to warrant its injection into this discussion by saying that the reason for the growth of the electric furnace, outside of the principle of electric heat itself, was automatic control. Rarely did we discuss the principles of how the heat was generated; always it was the possibilities of elimination of the human factor, the establishment of a governable temperature, and the possibilities of repeatable operations.

It may seem peculiar that a new product such as the electric furnace should be the introduction of automatic control rather than fuel fired units. The only answer I can give to that question is that the electric furnace came into existence during what might be termed the electric epoch of American industry.

It may have been just as well that control of heat commenced in this way, for as the electric furnace was purchased as a luxury in the early days, it was purchased by organizations that could afford a luxury and at the same time could afford research. It was this research which has developed the facts and specifications that have made modern metallurgical mass production possible, and it was the metallurgical research engineer who discovered the need and value of control.

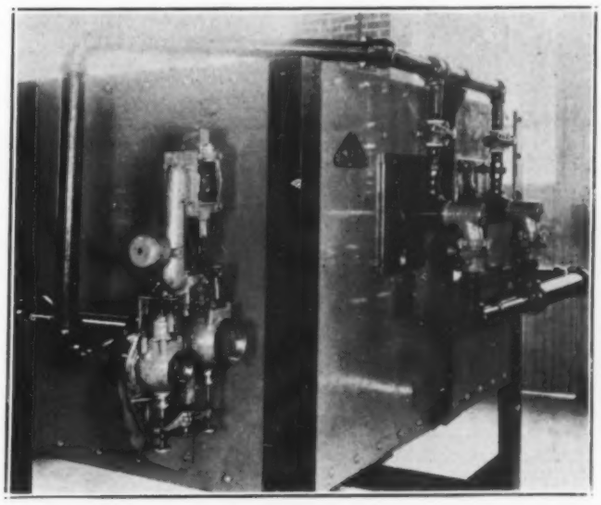

FIG. 2—Control inserted on portable forging furnace.

Having been familiar through association with the development and introduction of the electric furnace because our company's facilities had been increased through the absorption of one of the oldest fuel furnace organizations, it was quite natural that we should give thought to the possibilities of control on fuel fired furnaces. On first consideration of the subject, we were slowed up by the simple question, "Why had no one done it before?" There did not seem to be many complications in designing satisfactory equipment, therefore, "Why had it not been done?" I suppose the best answer to that question is the fact that this country has been over burdened

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†Engineer, Ryan, Scully & Co.

with basic fuel supplies. Most of us can remember the days of its wastage. In fact, the wastage is still alarming, but more from the standpoint of lack of knowledge than from known conditions as it was in the past.

We produced the first group of control in 1921, the time, you will remember, when conservation as stimulated by Secretary Hoover, began to take effect on industry, and the time when cost of materials began to go up and the efficiency of labor down.

The war had disorganized labor. The old reliable efficient furnace operator, "the man at the fire," had become disorganized, if not passed out of existence, and the young element coming into industry were

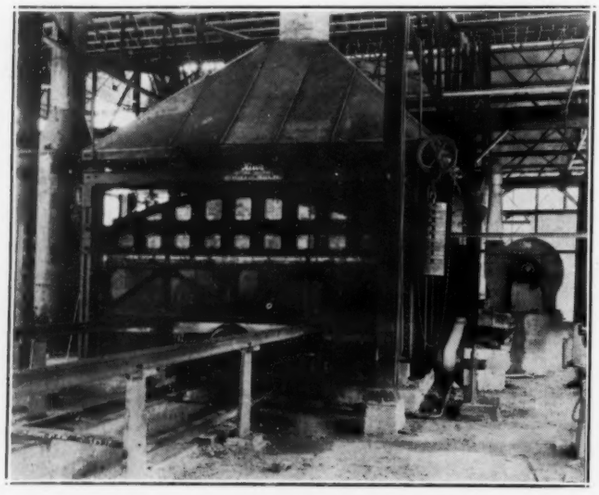

FIG. 3—Automatic Centrifugal Pipe Treating Furnace, Two Zone Controlled.

not interested. They wanted action—quick action, high wages and a never changing existence.

I made an investigation throughout the eastern and middle section industrial area during that period, and I believe a good many of you will agree with me that during 1920 and 1921, the percentages of defective material went up alarmingly. Concerns that had been in business for many years went out of existence because of the lack of quality in their product and those that remained in business were compelled to establish research divisions to discover the cause and cure.

I wonder how many of you gentlemen have stopped to consider the tremendous effect that heat has on all industrial life. Its cost is usually of the lowest consideration, but it is the foundation of success whenever it is used. Make your heating operation imperfect and you may get by, but an imperfect result never continues to get by for long.

For the above reason, you can see that industry was faced with the need of a new sort of mechanism to take the place of the man at the fire.

Many ideas were suggested, tested and fell by the wayside.

To our organization, it seemed that we must watch the electric furnace, that is, control the base from which the heat originated.

In a fuel fired furnace of either gas or oil type, "What were the controllable lines to be met with?" Simply, the fuel and the atomizing agent, whether steam or air of high or low pressure, heated or cold.

We realized that to develop a system which would necessitate new types of burners, burner application and furnace construction would only slow up its adoption, owing to the cost of scrapping the burner equipment already installed, and after preliminary study we observed there was no need of special burners; it was just the control of the fuel and atomizing delivery lines.

This brought us to the point of "Why had not the systems which involved automatic valve on each of the lines worked out?" That question can be answered by the one word "combustion" and the efficiency of that combustion.

From practical experience, you all know that there is probably no word which so ill describes industrial heating and the placing of the fuels in form for burning than "combustion." It is purely a relative term and must be so considered, for within it comes thousands of classifications.

Therefore you can see we had to develop an apparatus which had inherent possibilities of combustion control in addition to just temperature control. With this as a base, the Ryan system was developed, the equipment of which to outside appearance will be described by slides after the conclusion of this paper.

As I stated in the beginning, many engineering facts of the development would be passed over. Sufficient to say that the original models, although now

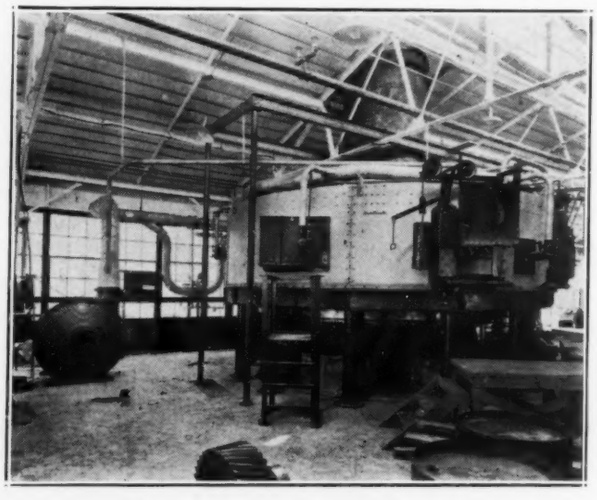

FIG. 4—Automatic revolving hearth forging furnace, combustion and temperature controlled at 2400°.

only five years old, are relics. We called them all in and replaced them. The second models are still giving good use and service, but these likewise have been improved as time went by, and added features of efficiency adopted. Those desiring to get a clearer picture of what the device is can do so by securing one of the general bulletins on this subject.

Coming now to the adoption of the equipment by industry, the first major organization, who by the way was the pioneer organization in the adoption of combustion and temperature control, was the United States Cast Iron Pipe and Foundry Company. Their history in the development of the centrifugal method of pipe casting is too well known to need descrip-

tion. One feature of interest to this discussion is the fact that the theory of pipe casting by the centrifugal method was not new. It had passed from South America to France, then to England, then to Canada, leaving behind a trail of failure.

Two problems were involved, a more satisfactory mechanical method of casting and a simpler and less costly method of annealing to remove the case that comes from casting in a metal mould. The problem of the heating furnace was submitted to our organization and in conjunction with the engineers of the Pipe Company, and a satisfactory furnace, that is,

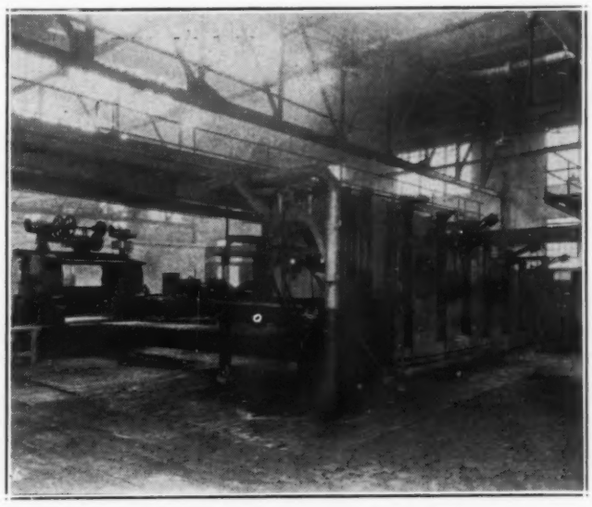

FIG. 5—Oil fired continuous billet heating furnace fully controlled.

it was satisfactory when considered in relation to past equipment, was developed. But, the objectionable feature of lack of automatic control that would allow quantity production, still continued. Six months after the installation of the first furnace control was installed, and a few of the resulting facts will be interesting.

The hand operated furnace had cost from 50c to 65c a ton for annealing. The furnace with control reduced these costs to 35-40c. The specifications on the contract for the furnace without control specified a maximum of 32 pipe per hour. The furnaces with control have produced as high as 110 pipe per hour, and average nearly 90. Furnaces without control and with control were tested and the percentage of good pipe produced with control as against expert hand operation were always higher, the fuel cost was always lower and the production greater.

Another fact of interest was the possibility of increasing the temperature of operation to give a better anneal. This increase was up to within a very few degrees of the collapsing point of the pipe, probably 150° closer than they would dare to operate with hand firing.

On the original design of the plant, it was the intention to have one furnace operator for each furnace. With control, one man takes care of a group of five furnaces and all of the mechanical equipment adjacent to the furnaces. Unbiased engineering organizations have run comparative tests attempting to secure like results with refinement of burners and firing auxiliaries, but at no time were they able to equal the reliability, the efficiency of production or the economy of the controlled unit.

The next installation which is of interest was that at the Heppenstall Forge & Knife Company. The negotiations for the purchase of the control were handled between the writer and Mr. S. B. Heppenstall personally. I mention this fact because I find the leaders of industry have been the prime movers, to date, in the adoption of control.

A study was made of the results to be obtained through control, its mechanical make-up, and especially of what detrimental factors might be established by its use. Suffice to say that the original installation met every guarantee, and it has now been exclusively adopted by their Pittsburgh and Bridgeport works.

I might give you some facts and figures developed on this installation, but I think of most interest is the statement by Mr. Heppenstall in answer to my question as to what he felt the control had accomplished. He stated that they had not kept an accurate cost record of fuel consumption because they manufactured a quality product and in order to obtain a quality product they knew that they had to have efficient operation, so that when they secured quality they thereby secured efficiency and economy. He stated also that he knew the production had been speeded up because the men at the presses and hammers now knew that the work was at correct temperature and there was not the hesitancy of operation that usually exists when operation must depend upon human observation.

Now let us consider John A. Roebling's Sons Company's continuous billet heating furnaces for

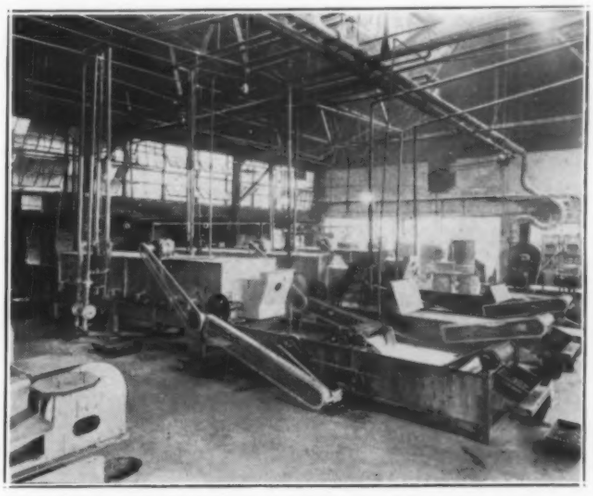

FIG. 6—Automatic bolt treating equipment, gas controlled.

steel and copper. The Roebling Company was experiencing, like many other organizations, the annoying break downs of the rolls, rejections, etc. Their metallurgical engineer, Mr. Boynton, had traced what he felt was the trouble, back to the furnace, an opinion that was not concurred in by some of his associate engineers. Finally, he presented a suggestion of co-operation between our organization and his to test out control with a view of eliminating their trouble. The controlled furnace entirely eliminated the trouble at the rolls.

We further proved on other installations that with the best operators that could be placed on a like furnace directly beside the one with the control, that we could exceed in production, produce a more satisfactory product and eliminate roll difficulty. Conclusive proof of this statement is the fact that all of the other furnaces both for steel and copper are now controlled.

Hupmobile, at Jackson, Mich., was the first major concern in the automobile industry to take up control equipment. When they decided upon the erection of a new heat treating plant and placed the problem

FIG. 7—Plant of Hupp Motor Company, Jackson, Mich., 100% combustion controlled.

in the hands of the engineers of our company we found in order to meet their requirements, furnaces must be developed of a type that had never been used before—furnaces of a type that could not be operated without control. The entire plant, of which I will show you slides, is now operated as it pertains to temperature and change of temperature, from the control room, and only one man is charged to furnace operation, this man also assisting in the removal of the treated products to the testing room.

This installation was so successful that the government selected it for the basis of a moving picture on modern heat-treating. I personally feel that a large amount of credit goes to the control.

Two other installations are those at the Witherow Steel Company and the Donner Steel Company. In each one there are large annealing furnaces for alloy steel. Close temperature control must be kept for long periods, averaging 30 to 40 hours. The atmosphere must be maintained reducing and the uniformity of temperature equal throughout the heating zone.

The test of the Witherow installation was based upon decarburization and temperature, with the use of 16 thermocouples located throughout the charge. A temperature variance not exceeding 10 degrees was maintained.

A number of other interesting installations will be described during the showing of the slides, when I trust that individual questions will be brought forth so that everyone may have a clear answer.

In concluding, the next point to be touched on brings us to a field of discussion wherein the wise man treads lightly, and for that reason, I want to present conclusions and observations rather than facts, principally because there has not been sufficient time to run down and positively check these conclusions and observations.

As you are all familiar with the existing theories of heat conductivity, I will not repeat many of those which are still in existence, such as, for instance, heat will penetrate so many inches of material in so many minutes, at such and such a temperature. Suffice to say that when we have checked many of these theories, we find that they are correct as far as they pertained to individual cases, but when they were applied to new conditions they usually don't check.

Until the development of automatic combustion and temperature control, there was really no possible means of studying the speed of conductivity in fuel fired furnaces, or the relation of oxidation to heat conductivity and the relation of temperature gradient to conductivity.

One interesting point that we have observed is that the less the oxidation that is allowed to develop, the faster the rate of uniform heating. Therefore, it would seem that oxidation develops an insulation to heat penetration.

Another interesting point is that the lower the temperature gradient the more uniform seems to be the curve of penetration. That is, let us say, the furnace temperature is 1650°, then the closer we can keep the working temperature, that is the temperature of the gases, to the temperature desired in the product, the more uniform is the speed of heating.

Right at this point, I know that someone is going to ask the question as to whether or not I intend to

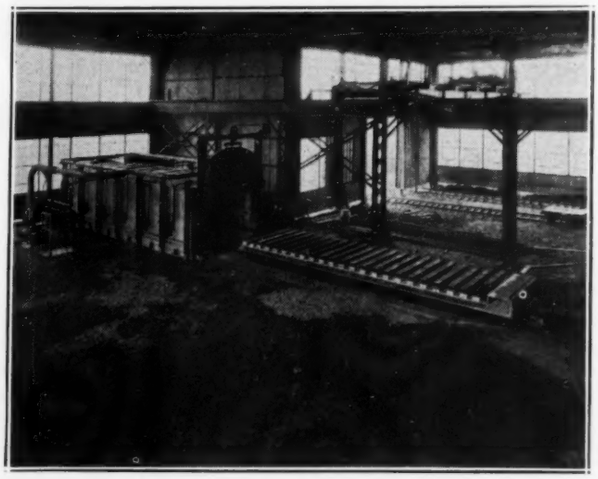

FIG. 8—75-ton alloy steel annealer, dual control for either by-product gas or oil.

imply that greater speed of heating can be accomplished at lower temperatures of heating than at higher temperatures. I do not mean to give such an impression. What I desire to state is that with a lower temperature of treatment, that is, by lower I mean being nearer the temperature of treatment, the more even is the curve of penetration, the less the fuel cost, the less the oxidation, and the more uniform the ultimate treatment.

This can be observed in a controlled continuous billet heating furnace. On a control furnace you

can bring the temperature down and have a thoroughly soaked billet with less oxidization and a lower fuel cost than you can at the higher temperatures.

I ask you to remember that I stated that these are conclusions arrived at by observation on the part of our research engineers. They are offered more from the view of having someone in this, or some other society take them and follow them through to either definite proof or disproof rather than asking you to accept them as conclusive facts.

Another case is that of a tool steel manufacturer who claims that they are now able to treat certain carbon steels and obtain results that are not obtainable by any other tool steel manufacturer. This statement might be taken with a grain of salt if it were not for the fact that whenever the control is in the need of repair, such as grinding of the seats, they will not operate the furnace, as previous results have shown that they cannot get the results they desire.

Chase Metal Works, which I believe is the largest producer of non-ferrous products in the country, became interested in control a little over two years ago, at which time they asked for a submission of equipment to make tests. These tests took place on various types of furnaces, with various types of burners and on various operation. Their Research Division furnished us with a statement that there was a 20% saving in fuel and an 8% greater production. Since then, their plant has been 100% equipped with control.

You will note that in numerous places I have spoken of a saving of fuel and you possibly question this saving as against a furnace with expert operators and running 24 hours a day. I will try to give you a little explanation of why we have found that combustion control saves over 20% and upward.

Let us take a furnace that has six burners and a desire to operate at 1650°. It is quite usual that the temperature and combustion will be set with an empty furnace so as not to spoil the initial charge. Then your man starts operating, putting in and taking out work. Unless the charging and discharging is automatic, you will admit that it is impossible to obtain a uniform cycle of operation. If he slows down the temperature creeps up and he makes a change on one or two of the burners. If it creeps down when he speeds up, he again makes a change. How long do you suppose it takes to make those changes and also, have you ever observed how long it takes a man to set the average high grade burner to a good balance combustion?

Based upon checkings, we have found that it will take a man five to eight minutes to place six burners in balance of good combustion and it will take the same length of time to change that balance. The result is that in a hand fired furnace combustion is usually of a low percentage and the changes made during an operating period are just changes to obtain either a reduction or an increase of heat with little regard to the problem of combustion.

Against the above condition, let us look at the controlled furnace. The control valve has a number of dials which govern the by-pass, the main flow and speed of heating. We will say, therefore, that the operator in the morning places his furnace in balance, or in good combustion, his pyrometric controller is turned into the circuit and he starts operation. The controller will change, if necessary, the temperature 15 to 25 times a minute. Consider this against the average of eight minutes. Then, too, recognize that each change is purely a change of delivery and not a change of balance. Therefore, with each upward and downward cycle the same ratio of efficiency in combustion is maintained. That is the simple answer to why control saves fuel.

My particular position in the organization with which I am connected is to a large degree administrative, along selling and merchandising lines. For that reason, I have a strong tendency toward studying the angles of sales approach, that is, the big fundamental features. Therefore, I have been interested in the personal improvements that can be brought to industry with the use of combustion control systems.

I have found that the fact that combustion control takes the problem of the furnace out of the hands of the material handler is one of the most outstanding advantages. In addition, it dissipates the old alibi that the furnace was not ready and it sets up a very definite knowledge to the department head that he

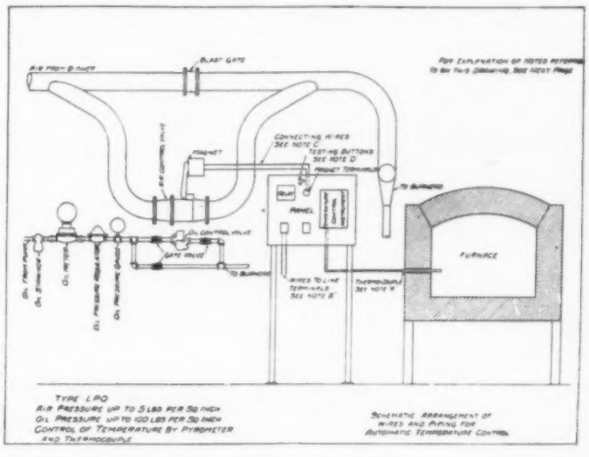

FIG. 9—Schematic arrangement of wires and piping for automatic temperature control.

is no longer dependent upon the eye heat-treating specialist. When material is spoiled in heating, he can tell why it is spoiled, at what time it was spoiled and who is to blame for the spoilage.

In one case, that of a large automobile concern, the main plant is located some seventy miles away from the head office at Detroit, where the Metallurgist is stationed. Every night the records of the day's operation as made by the recorder controllers are sent to Detroit, and there inspected, the first thing in the morning, in conjunction with the production records.

This official told me, not long ago, that with control installed they have practically eliminated the wide variables that used to exist in production; that they practically never have a shut down because of sickness, for any of the men can duplicate on any other operation. They have also found that their labor difficulties have been reduced: the men seemed more satisfied, principally, he felt because they realized they had a good job, but a job which can be taken by some other man at a moment's notice, if necessary, and carried through satisfactorily.

You will probably know by this time that my statement that this paper was going to be general in character was correct, but I again reiterate that this was intentional. My experience through a number of years and in the delivery of numerous papers of this sort has proven to me that open discussion is worth a dozen papers. You see I have lived with this subject since its instigation and things that will be important to you are every day happenings and non-important to me. Personally, I have always felt that a paper of this sort should really be a joint affair, you on the asking end and the presentor of the paper on the other.

I trust, therefore, that you will get into the discussion, asking as many embarrassing questions which I may not be able to answer, as you desire, but on the other hand, no doubt you will ask many to which I can give answer.

Finally, I trust you will all give a little more thought to this really important subject, for its understanding and proof rests largely within your hands rather than in our hands as the originators of the device that has made it possible.

Mills of the Backed Up Type Remove Cold Rolling Limitations

By LLOYD JONES*

THE application of mills with backed up rolls is not new, and has been practiced throughout the metal rolling industry continuously in various forms and shapes for over sixty years. There are approximately five types of backed up mills, as follows:

(1.) The Three-Roll type, of which the Lauth Plate Mill is the leading example, and is in general use throughout America. In this mill the two large rolls alternately become supporting rolls to the middle roll as the plate or sheet is run between the middle and the top roll, or between the middle and the bottom roll. Another common use for the Three-Roll backed up mill has been in the hot and cold strip industry, where its use has been common for over 20 years.

(2.) The Four-Roll backed up mill, where each working roll has one supporting roll.

(3.) The Six-Roll mill, commonly called the Cluster Mill, where each working roll has two supporting rolls.

(4.) The Seven-Roll mill, or what might be termed the Three-High Cluster Mill, wherein there are three working rolls, the top and bottom of these rolls being each supported by two backing up rolls.

(5.) There is another type of Four-Roll backed up mill, of which there have been seven built. This is a modification of the Three-Roll mill. In this case, on account of the very small diameter of the work roll, it was supported on the bottom by two backing up rolls, the metal passing between the small roll and the large top roll. In this particular type of mill, rolls as small as 2" in diameter were successfully used in reducing wide metal.

Of these various types, the Three-High is in most general use, with the Four-Roll and the Cluster types following in order as named.

For the rolling of sheets and strips, the Four-Roll type and the Cluster type are better adapted than the Three-Roll type, and will eventually supersede it altogether.

As to the relative merits of the two outstanding types of backed up mills, namely the Four-Roll and Cluster types, their relative merits may be presented as follows:

Four-Roll Type

(1.) Less number of rolls.

(2.) Shorter distance from the edge of the housing to the center of the mill.

Cluster Type

(1.) No bearings for holding the work rolls in alignment are necessary.

(2.) The working roll cannot wear out of alignment; hence the Cluster Mill operator does not experience the difficulty which the Four-Roll operator experiences, due to the terrific end thrust of the working rolls when they become slightly crossed.

(3.) The working rolls can be more quickly changed, as there are no bearings to handle.

(4.) The working rolls automatically align themselves when placed in the mill by coming in contact with the two supporting rolls, eliminating the human element in lining up the mill.

(5.) The contact pressure between the work rolls and the supporting rolls is approximately 30% less per inch of face on the Cluster Mill, as compared to the Four-Roll mill.

(6.) The working roll is supported in both directions of force, and hence smaller diameter rolls can be used to accomplish the same work.

(7.) With equal diameter of working roll, and with the ratio of the backing up roll to the working roll approximately 2 to 1, which is the general ratio, the Cluster Mill has approximately 40% greater capacity.

The E. W. Bliss Company, at their Salem Plant, builds both types of mills, and has both types of mills in successful operation. The price of either type is approximately the same.

In regards to holding the rolls in alignment on the Four-Roll type, we have had our difficulties. The brasses on the necks become worn, or the mill is not set in correct alignment, and the rolls quickly develop an end thrust which makes the changing of the roll neck brasses necessary at frequent intervals. To overcome this tendency, the

*General Manager, E. W. Bliss Company, Salem, Ohio.

last Four-Roll mill which we shipped to the American Sheet & Tin Plate Company was equipped with roller bearings on the working rolls as well as on the supporting rolls. We were able to accomplish this, because the mill was to be used for cold rolling purposes, and the working rolls were made of hardened tool steel, which allowed us to reduce the neck diameter sufficiently to install the bearings, and at the same time have sufficient strength to prevent the neck from twisting off.

It is a question in our minds whether this can be successfully done when the mill is used for hot rolling purposes, especially with rolls made of chilled iron. In this case we have to deal with a metal of low strength, and the torsional stresses would probably twist off the neck.

An illustration having to deal with supporting the rolls in both directions is the following experience. On the Four-Roll mill if a cobble takes place, the working rolls are apt to break and fly out of the mill. On the Cluster type of mill, we had an accident where the metal being rolled escaped between the roll surface and the stripper and passed around the working roll between the supporting rolls approximately six times before the mill was stopped. The only damage that occurred was that the working roll was marked and had to be taken out and redressed. No damage was done to the supporting rolls or to the roller bearings, and the six thicknesses of metal were reduced to the single thickness being rolled, the six laminations being actually welded together cold. This was a remarkable example of the enormous pressure which roller bearings will stand, and the method of supporting the work roll.

We have been applying roller bearings to mills for the last three years on all types of mills,—Four-High, Cluster type, and also on the ordinary Two-High mills. Our experience so far with roller bearings has been excellent, as we have had no failure or replacements to date.

In regards to the application of roller bearings to mill, this, like the backed up roll principle, is old, as to the writer's knowledge roller bearings on both Two-High mills and backed up mills have been in actual use for probably 16 years in this country.

The construction of the Four-Roll and Cluster types of mills render themselves ideally to the aplication of roller bearings. This is one of the reasons why mills of these types are rapidly coming into favor. The power saved by the use of the small diameter rolls is not as great as the power saved by the use of roller bearings. The roller bearing application, however, is spreading to Two-High mills, and we have a number of them in operation at the present time.

With reference to the adjustment of rolls in the backed up mills, there is no difference in the principles involved, and the only departure has been the application of electric power to the screw downs in place of hand power. This, of course, is not new on Plate Mills, Blooming Mills, etc., but is new to the sheet and strip industry. In regards to the adjustment of the rolls as far as alignment is concerned, our practice is to so build the mill that the workman has nothing whatever to do with it.

In the Cluster Mill the working rolls align themselves. In the Four-Roll mill for cold rolling we put roller bearings on the work rolls, and take away all adjustment features. For hot rolling, where we have difficulty applying roller bearings to the working rolls, we believe that the best solution to this problem will be the adoption of the Cluster type of mill in place of the Four-Roll mill. This will tend to solve several difficulties present in the Four-Roll mill, which has up to date been generally used for hot rolling, namely:

1. Alignment of the working rolls.
2. Increasing the life of supporting roll surface from 30% to 50%.
3. Decreasing roller bearing troubles now experienced.
4. Reducing work roll breakage.

Another interesting feature about backed up mills is that on account of the small arc of contact with the metal being rolled, the total bending load on the mill is considerably less. This cuts down the deflection or spring in the mill, and in many cases obviates the necessity for crowning the rolls. The practice of shaping the surface of the roll to deliver a sheet or strip within commercial tolerances has been common practice ever since the speaker has had anything to do with the steel business.

When the first Cluster Mill was installed at Huntington in the early part of 1923, we assumed that it would be necessary to crown the working rolls and started that mill with the one roll straight and other one crowned. The backing up rolls were all straight. We soon found that we did not need as much crowning, and this has been gradually reduced until the present practice uses very little crowning.

This question of shaping the rolls is becoming of less importance every day, and our practice now is to ship the mills from our shops with rolls ground perfectly straight. Whether crowning of the rolls is necessary or not seems to depend a good deal upon the product which is rolled in the mill. With the use of roller bearings, which eliminates the heat produced by neck friction, the swelling of the rolls, at their ends, due to increased temperature is being eliminated, and this in turn has a tendency to do away with the old practice of shaping the rolls.

It might be well at this time to touch lightly upon the historical phase. We find in about 1913 eight Cluster Mills in operation, and one Four-Roll Mill. About 1916 the second Four-Roll Mill was installed at Lukens Steel Company. From then we have a gap of approximately seven years, until 1923, and since then we have had tremendous building of backed up mills.

What caused this sudden revival of the backed up mill?

During 1922, the International Nickel Company, at their plant at Huntington, West Virginia, were making full finished nickel, and Monel metal sheets. In order to secure the desired surface they found it necessary to grind, polish, and buff the sheet before sending it out to the trade. This was a slow and costly process.

In talking the matter over with their Dr. Thompson, and Mr. Wotherspoon, the speaker proposed

cold rolling as a solution. We conducted some experiments and found that by reducing the thickness by cold working, we could secure a surface which would eliminate the grinding process. These experiments were conducted on the ordinary Two-High mill with strips approximately 18" wide.

To accomplish the same amount of reduction on 36" wide sheets, on the ordinary Two-High cold rolling sheet mill, of which they had several in their plant, the rolls being 26" in diameter, we found it would be necessary to make from 40 to 60 passes. The speaker then proposed a mill of the backed up principle, and we were all convinced that was our only solution to the problem.

When it came to the choice of backed up mill, there were two types. The speaker was well acquainted with the Four-Roll type built for Lukens Steel Company, as all drawings for this mill, prior to being issued to the shops had his signature of approval on them. He was also familiar with the Cluster type of mill which had been operating since 1913. In studying over the advantages of the two types of mills at that time, his preference fell to the Cluster type, and this type was installed at Huntington.

We quickly found that we could accomplish in three to four passes on this mill what took forty or more passes on the regular 26" mill. This mill was visited by practically every sheet and strip manufacturer in the country, and many of the prominent sheet manufacturers sent sheets to Huntington to be cold rolled.

This was really the starting of the modern strip method of rolling sheets, because it removed the limitations on the old hot and cold rolling strip practice, and allowed them to adopt this practice to widths wider than they had been rolling, and further encroach upon the sheet trade.

The International Nickel Company are to be commended upon the courage displayed in investing approximately $100,000 in an experiment which a great many sheet operators predicted was doomed to failure, and it remained for a producer of non-ferrous sheets to open the eyes of the great sheet and tin plate industry of America.

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*A Year's Operation of Power Plant at Betty Furnace, Central Alloy Steel Corporation**

By J. D. DONOVAN†

THE new power plant of the Central Alloy Steel Corporation at Massillon was first placed in service October 1, 1926. As performance is the measure of merit, some comment on the operation may be of interest.

Perfect continuity has been maintained at the boiler house. Through use of the two turbo-blowers there have been no furnace delays of import attributable to lack of wind. The single turbine generator has a remarkable record of performance in that it has operated continuously with a total outage of only nine hours, all of which was planned due to initial inspections at the turbine and condenser.

The turbine generator has produced an average output in excess of 6,000,000 kw.-hr. per month, reaching 7,159,000 kw.-hr. during the maximum month. This high output ratio, averaging on the order of 85 per cent, has been possible because of the favorable power interchange arrangement and because of the good power factor of the load. The turbine generator unit, rated at 10,000 kw., 12,500 k.v.a., has carried 12,000 kw. load for many successive hours and without appreciable current overloads. A careful watch and record is kept of the temperature of the windings and the water circulation in the air coolers is governed to maintain a safe condition.

The boilers have proven their ability to carry the ratings specified under the natural draft. In the matter of efficiency, the boilers have exceeded their guaranties. Equipment acceptance tests on constant loads showed overall boiler efficiencies averaging well over 80 per cent either on blast furnace gas or pulverized coal.

Contributing notably to the excellent performance of the boilers on blast furnace gas fuel is the absolute freedom from sludge and moisture in the gas mains and burners. This gas condition is brought about through use of the heat interchanger. In the interchanger all the entrained moisture in the gas is vaporized and a sensible heat rise averaging about 35 deg. F. is imparted to the gas. Experience has shown that this nominal rise is ample to ensure a temperature well above the dewpoint at the boilers. Because of the dry character of the gas there is no exterior encrusting of boiler tubes and the dust deposit is much less than the ash resulting from the use of pulverized coal. At one time during the year the heat interchanger was taken off for cleaning. A very marked difference in the quality of the gas was then evident.

Of the total steam production approximately 65 per cent is from blast furnace gas, 15 per cent from coke breeze, and 20 per cent from Ohio slack coal. Approximately 25 per cent of the steam produced is used by the turbo-blowers and their auxiliaries. About 60 per cent of the total steam production is used for electric power generation, inclusive of auxiliaries. The balance is process steam to blast furnace and coke ovens, together with radiation and transmission losses.

During the winter months a vacuum of about 28½ in. of mercury is obtained. During the sum-

*Credit extended Freyn Design, November issue.

†Superintendent, Electrical and Mechanical Depts., Central Alloy Steel Corporation.

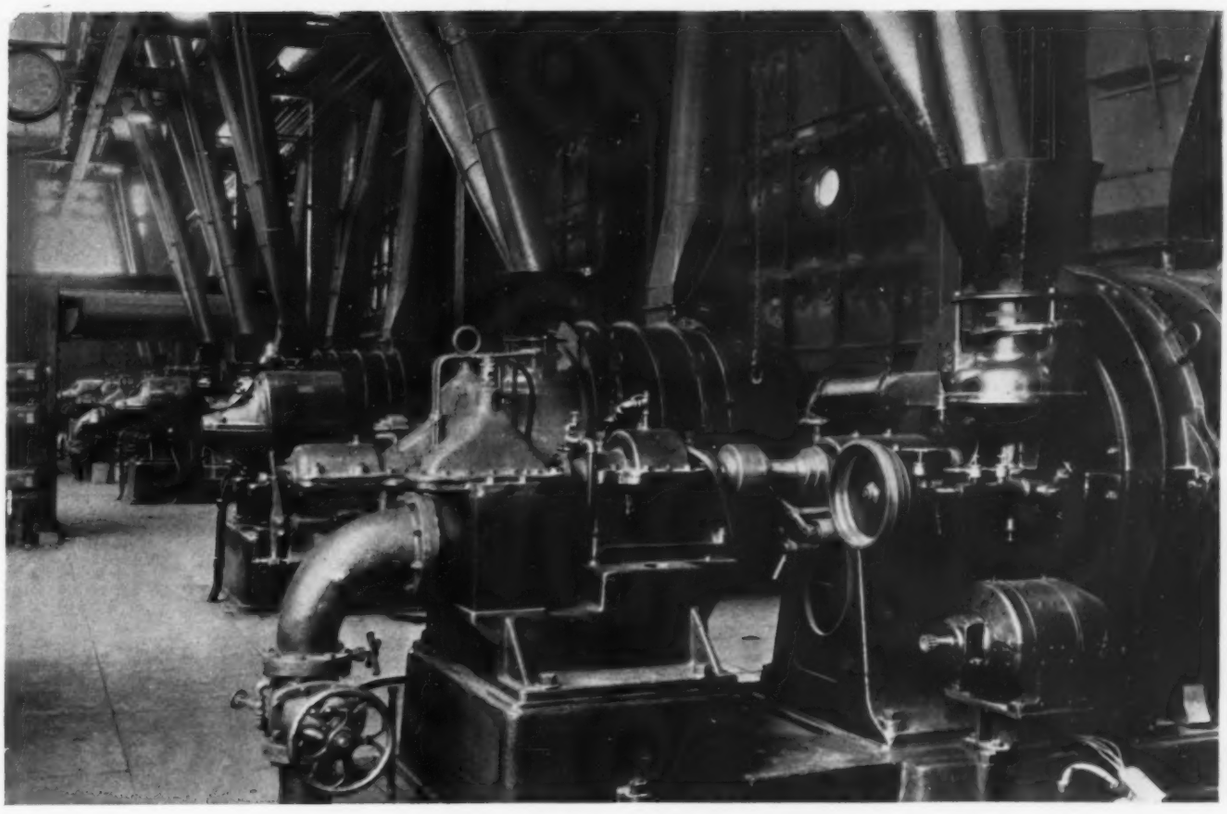


FIG. 1—Pulverizers in Boiler House.

mer months the vacuum drops off to about 27 in. An average of 13 to 13.5 lb. of steam is required by the turbine generator and its steam auxiliaries per kw.-hr. of electric power generated. The heat input per net kw.-hr. of station output, inclusive of losses, motor driven auxiliaries, etc., is about 17,000 B.t.u.

The power plant operating force consists of one water tender and two firemen in the boiler house and two watch engineers, one oiler and one switchboard operator in the power house. Two men on single turn handle the solid fuel and the ashes. Two general repair men on single turn are employed largely upon work about the power plant. One chief operating engineer and one boiler room foreman, on single turn, supervise all operations.

A system of signal interchange between the blast furnace and the power house has enabled the boiler operators to shift fuels on short notice without loss of steam pressure or wastage of heat through safety valve losses.

Computed on a coal equivalent basis, under which both the blast furnace gas and the coke breeze are evaluated, the operating cost per kw.-hr., inclusive of fuel, operating and maintenance expenses, is less than $0.003 per kw.-hr. Because of the moderate first cost of the station and the high output ratio, the fixed charges per kw.-hr. are low, being materially less than the operating cost.

PRINCIPAL EQUIPMENT USED IN POWER PLANT OF CENTRAL ALLOY STEEL CORP.

General

Location of plant ---------- Massillon, Ohio
Character of service ---------- Electric power, light and compressed air for blast furnace plant

General dimensions—

Boiler house	174 ft. x 76½ ft.
Turbine room	140 ft. x 62 ft.
Electrical bay	140 ft. x 30 ft.

Boiler House Equipment

6 Babcock & Wilcox Co. Stirling boilers, 890 hp. with integral economizers; 8,900 sq. ft. heating surface; 300 lb. steam pressure. Five, blast furnace gas or powdered coal; one, coke braize or coal.

6 Babcock & Wilcox Co. superheaters, 150 deg. superheat.

5 Erie City Iron Works water screens, 235 sq. ft. each.

10 American Heat Economy Bureau gas burners, 2 on each boiler.

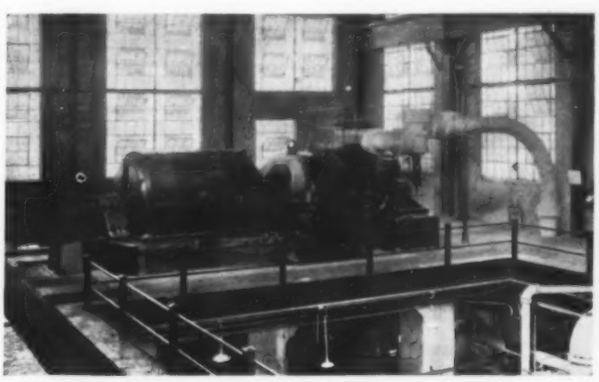


FIG. 2—Turbo-Generator.

20 Erie City Iron Works pulverized coal burners, 4 on each boiler.

8 Erie City Unit Pulverizers No. 4, Seymour Impact type, driven by

6 General Electric 75-hp., 900-r.p.m., 2300-v. motors, directed connected, and

2 Westinghouse 75-hp., 3710-r.p.m. geared turbines.

1 Riley Stoker Co. Harrington chain grate stoker, 237 sq. ft. area, driven by

1 4x4 Troy engine, with enclosed gear drive.

1 Buffalo Forge Co. fan for stoker, 27,000 cu. ft. per min. at 4.5 in. pressure, driven by

1 Westinghouse 30-hp., 3660-r.p.m. geared turbine.

2 Buffalo Forge Co. fans for air to gas burners. 60,000 cu. ft. per min. each at 7-in. pressure, driven by

1 General Electric 100-hp., 1800-r.p.m., 2300-v. motor and

1 Westinghouse 125-hp., 3380-r.p.m. geared turbine.

Feed water regulators (Copes)---Northern Equipment Co.

Soot blowers---Diamond Power Specialty Co.

Boiler arches---Liptak Firebrick Arch Co.

Boiler side walls ---
Waite & Davey air-cooled side wall blocks, Dobie & Co.

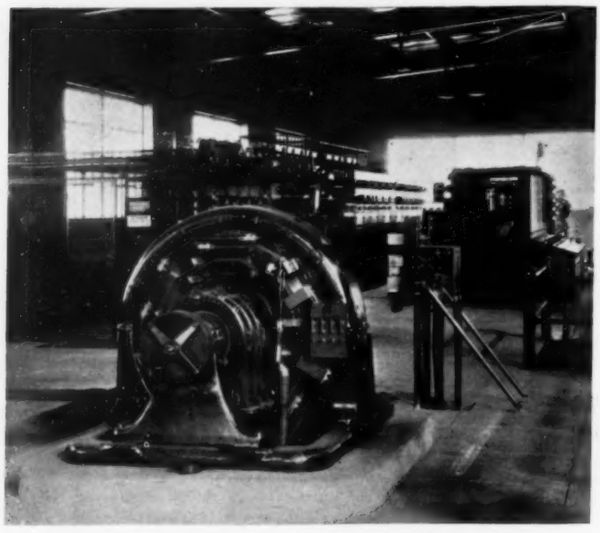


FIG. 3—Synchronous converters.

Ash hoppers and gates---Beaumont Mfg. Co.

Coal handling and crushing---Link-Belt Co.

Combustion control---Benjamin Engineering Co.

Stack---Rust Engineering Co., 365 ft. x 19 ft.

Prime Movers, Generators and Auxiliaries

1 General Electric 10,000-kw. Curtis turbine, 9-stage, 1800-r.p.m. bleeder type, driving a 4-pole, 11,000-v., 12,500-kv.a. 80 per cent power factor, 3-phase, 60-cycle generator. Turbine designed for steam at 275 lb., 150 deg. superheat.

2 General Electric turbo-blowers, 3-stage, 3370 to 4150 r.p.m., 50,000 cu. ft. per min. at 18.4 to 32.7 lb. pressure, driven by 3950 to 5300-hp., 8-stage condensing Curtis turbines, designed for 275 lb., 150 deg. superheat.

1 General Electric generator air cooler, 2 units, 227 sq. ft. each.

1 Andale oil cooler, Andale Engineering Co.

2 Schutte & Koerting oil coolers for blowers.

3 General Electric synchronous converters, 6 pole, 550-kw., 1200-r.p.m., 250-v., 2200-amp. 6-phase, 60-cycle.

4 General Electric switchboards; 9 panel main board, 11,000-v.; 11 panel 2300-v. distribution board; 10 panel 250-v. d.c. board; 1 250-v. field control board.

1 Electric Storage Battery Co., 110-volt, storage battery for emergency lights and switch control.

9 General Electric, 200-k.v.a., 11,000/187 volts, single phase, 60-cycle transformers for supply to rotaries.

7 General Electric, 500-k.v.a., 11,000/2,300 volts, single phase, for local power supply.

Condensers and Auxiliaries

1 Worthington Pump & Machinery Corp. 14,400-sq. ft., 2-pass surface condenser for turbo-generator, equipped with duplicate 2-stage, 20-cu. ft. steam jet air ejectors, all mounted over one common surface inter- and after-cooler combined in one shell, equipped with valves so that either or both may be operated.

2 Worthington 6400-sq ft., 2-pass surface condensers for turbo-blowers, each equipped with duplicate 2-stage, 11-cu. ft. steam jet air ejectors, mounted same as turbo-generator.

Pumps and Drives

1 Worthington 24-in. type OS centrifugal circulating pump, 16,100 g.p.m., against 45 ft. head, for circulating water to turbo-generator condenser, driven in dual drive by

1 General Electric type I-M-17-A 250-hp., 2300-v., 3-phase, 60-cycle, 600-r.p.m. motor and

1 Westinghouse 250-hp., 4040-r.p.m. geared turbine.

2 Worthington 4-in 2-stage hot well pumps, (for turbo-generator condensate), 315 g.p.m. against 85 ft. head driven by

2 Westinghouse 20-hp., 1750-r.p.m. turbines.

2 Worthington 16-in. type OS circulating pumps (for blower condensers), 7000 g.p.m. against 50 ft. head, driven by

2 Westinghouse 125-hp., 3370-r.p.m. geared turbines.

4 Worthington 3-in., 2-stage hot well pumps (for turbo-blower condensate), 140 g.p.m. against 85 ft. head, driven by

4 Westinghouse 12½-hp., 1200-r.p.m. turbines.

3 Worthington 10-in. 2-stage close coupled centrifugal service pumps, 3500 g.p.m., driven by

3 General Electric 250-hp., 1200-r.p.m., 2300-v. squirrel cage motors, direct connected through flexible couplings.

2 Worthington 6-in. centrifugal pumps for cooling water, 1000 g.p.m. against 100 ft. head, driven by

2 General Electric 40-hp., 1800-r.p.m., 220-v. motors.

2 Worthington 10-in. centrifugal furnace circulating pumps, 3000 g.p.m. against 100 ft. head, driven by

2 Westinghouse 100-hp., 1750-r.p.m. turbines and

1 General Electric 100-hp., 1800-r.p.m., 2300-v. motor in dual drive.

3 Worthington 5-in. Jeanesville 4-stage centrifugal boiler feed pumps, 650 g.p.m. against 875 ft. head, driven by

3 Westinghouse 225-hp., 1850-r.p.m. turbines.

1 Worthington 18-in. by 11-in. by 24-in. horizontal duplex plunger pump. Water end suitable for 500 lb. pressure.

1 Nash Engineering Co. Jennings Hytor Condensation pump, driven by

1 General Electric 3-hp., 1750-r.p.m. motor.

Water Treating and Heating Equipment

1 Permutit Co. 60,000 g.p.h. cold continuous treating plant.

1 Permutit Co. 2-unit zeolite softener.

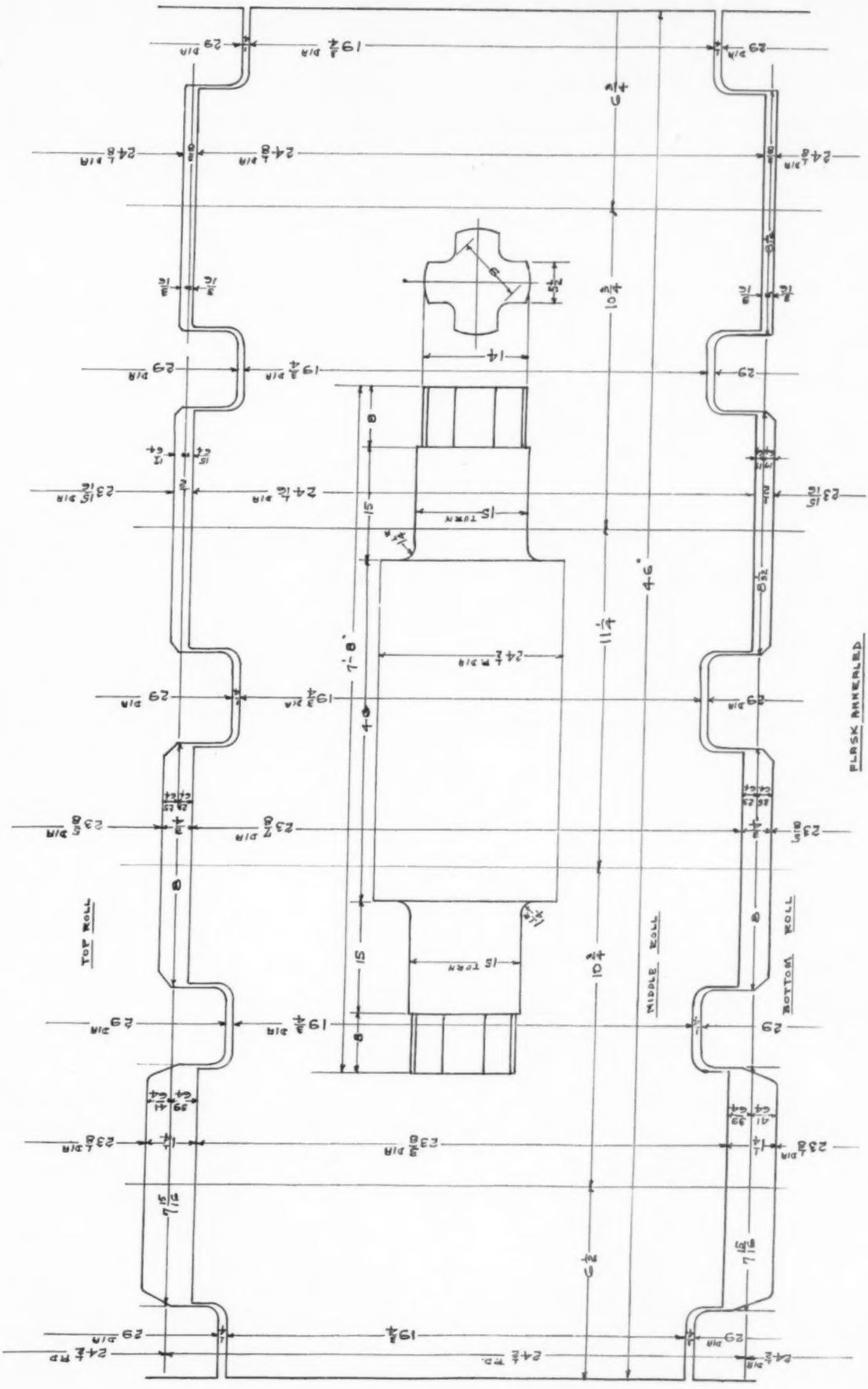
1 Griscom-Russell condenser type bleeder heater, 178,600 lb. water per hr. from 92 deg. to 149 deg. with 10,300 lb. per hr. bled steam at 7.4 lb. absolute.

1 Griscom-Russell Contraflo deacrating heater, 326,000 lb. per hr. from 140 deg. to 195 deg. with 18,200 lb. per hr. auxiliary exhaust steam at 5 lb. gage pressure.

Miscellaneous

1 Ingersoll-Rand air compressor, 12 in. by 10 in. driven by Electric Machinery Mfg. Co. synchronous motor.

Spray Pond---Spray Engineering Co.



24" SHEET BAR ROLL

The slab which this mill takes is 1⅛" x 7½" rolled in four passes and one bull head pass to sheet bar of varying thickness.

The readers of the Iron and Steel Engineer are invited to criticize the design of this roll and all comments should be addressed to us at 705 Empire Building, Pittsburgh, Pa.

DEPARTMENT OF COMMERCE
BUREAU OF MINES

COKE AND BY-PRODUCTS TABLES, 1926

These tables give the final statistics of production of beehive and by-product coke in the calendar year 1926, based upon complete returns from the producers. They were published in the weekly coal reports between August 13 and September 24, 1927. A list of the tables follows:

Statistical summary of the coke industry

By-product and beehive coke produced, by States

Monthly production of by-product and beehive coke, revised

Beehive coke produced, used by producer, and sold, by States

By-product coke produced, used by producer, and sold, by States

Number and production of by-product coke plants connected with iron furnaces and of all other plants, 1913-1926

By-products obtained from coke-oven operations

Average yield of coke and by-products per net ton of coal charged in by-product ovens in the United States, 1915; and 1919-1926

Value of by-products and of coke, including breeze, per ton of coke produced in the United States, 1915; and 1919-1926

Average receipts per unit of coke-oven by-products sold, 1913-1926

Disposal of coke-oven tar produced in the United States, in 1925-1926, in gallons

Disposition of gas from by-product ovens in the United States, 1925-1926

Average receipts per ton from sales of coke and breeze, 1918-1926

PRODUCTION OF BEEHIVE COKE IN 1926.

MONTHLY PRODUCTION OF COKE IN THE UNITED STATES IN 1926 - FINAL REVISED RETURNS

Month	By-product	Beehive	Total
January	3,796,000	1,500,000	5,296,000
February	3,492,000	1,524,000	5,016,000
March	3,772,000	1,259,000	5,031,000
April	3,604,000	1,068,000	4,672,000
May	3,725,000	964,000	4,680,000
June	3,614,000	882,000	4,496,000
July	3,771,000	856,000	4,627,000
August	3,742,000	818,000	4,560,000
September	3,640,000	892,000	4,532,000
October	3,799,000	943,000	4,742,000
November	3,730,000	935,000	4,665,000
December	3,692,000	848,000	4,540,000
Total for year	44,377,000	12,489,000	56,866,000
Monthly average	3,698,000	1,041,000	4,739,000

BEEHIVE COKE PRODUCED, USED BY THE PRODUCER, AND SOLD, 1926

State	Produced		Used by producer in blast furnace, etc.	
	Net tons	Value	Net tons	Value
Colorado	197,179	(a)	42,621	(a)
Georgia	3,059	$ 23,034	- -	- - -
Kentucky	147,540	600,159	64,196	$ 320,980
Ohio	84,970	(a)	83,035	(a)
Pennsylvania	10,722,352	47,595,184	1,177,699	5,167,878
Tennessee	122,410	605,017	83,158	415,790
Utah	121,475	1,033,284	- -	- - -
Virginia	370,983	1,716,716	19,322	82,217
Washington	24,702	214,429	- -	- - -
West Virginia	583,599	2,682,219	93,321	426,407
Alabama and New Mexico	110,682	730,590	11,687	63,255
Undistributed	- - -	1,854,227	- -	672,454
	12,488,951	57,024,869	1,575,039	7,148,961

State	Sold for furnace use				Sold for foundry use	
	To affiliated corporations		Merchant sales			
	Net tons	Value	Net tons	Value	Net tons	Value
Colorado	134,228	(a)	- - -	- -	2,949	(a)
Georgia	- - -	- -	- - -	- -	2,938	$ 22,135
Kentucky	- - -	- -	- - -	- -	82,375	274,776
Ohio	- - -	- -	38	(a)	- - -	- - -
Pennsylvania	4,026,041	$18,728,618	3,775,037	$14,321,473	761,422	3,991,973
Tennessee	- - -	- -	28,795	129,869	10,511	61,377
Utah	- - -	- -	121,475	1,033,284	- - -	- - -
Virginia	48,823	184,434	18,599	75,611	110,680	557,918
West Virginia	- - -	- -	212,088	823,219	184,824	993,291
Ala. and N. Mex.	50,936	(a)	- - -	- -	7,961	(a)
Undistributed	- - -	1,393,401	- - -	550	- - -	66,466
	4,260,028	20,306,453	4,156,032	16,384,006	1,163,660	5,967,936

State	Sold for domestic use		Sold for industrial and other use		Total sales	
	Net tons	Value	Net tons	Value	Net tons	Value
Colorado	17,320	(a)	- - -	- -	154,498	(a)
Georgia	- - -	- -	- - -	- -	2,938	$ 22,135
Kentucky	- - -	- -	519	$ 1,849	82,894	276,625
Ohio	- - -	- -	- - -	- -	38	(a)
Pennsylvania	343,787	$ 2,375,582	643,549	3,046,309	9,549,836	42,463,955
Tennessee	- - -	- -	500	1,250	39,806	192,496
Utah	- - -	- -	- - -	- -	121,475	1,033,284
Virginia	4,120	29,434	167,370	775,676	349,592	1,623,073
Washington	- - -	- -	24,702	214,429	24,702	214,429
West Virginia	20,668	127,216	86,948	363,521	504,528	2,307,247
Ala. and N.Mex.	149	(a)	40,209	235,508	99,255	668,917
Undistributed	- - -	145,509	- - -	- -	- - -	1,172,517
	386,045	2,677,741	963,797	4,638,542	10,929,562	49,974,677

a Included under "Undistributed."

DEPARTMENT OF COMMERCE
BUREAU OF MINES

PRODUCTION OF COKE AND BY-PRODUCTS IN 1926

Final statistics of the coke industry in 1926, based on complete returns received by the Bureau of Mines from producers, are given in the following tables. The figures relate exclusively to beehive and by-product coke and do not include the output of petroleum coke, which amounted in 1925 to 995,000 tons, nor of retort or gas-house coke, the sales of which amount to between one and two million tons a year. The figures include installations of by-product coke ovens operated in conjunction with city gas supply, and in this respect differ from the compilations of the Census Bureau which treat such installations as a part of the city gas industry.

STATISTICAL SUMMARY OF THE COKE INDUSTRY IN 1926

	By-product	Beehive	Total
Coke produced:			
Quantity.....net tons	44,376,586	12,488,951	56,865,537
Value	$250,748,533	$57,024,869	$307,773,402
Screenings and breeze produced:			
Quantity.....net tons	4,183,453	218,342	4,401,795
Value	$ 9,233,229	$ 648,193	$ 9,881,422
Coal charged into ovens:			
Quantity.....net tons	63,646,610	19,224,500	82,871,110
Value	$247,170,284	$38,541,691	$285,711,975
Average value	$ 3.88	$ 2.00	$ 3.45
Average yield in per cent of coal charged:			
Coke	69.7%	65.0%	68.6%
Breeze (at plants actually recovering)	6.6%	2.8%	6.2%
Ovens:			
In existence Jan. 1	11,290	57,587	68,877
In existence Dec. 31	11,716	52,558	64,274
Dismantled during year	183	5,019	5,201
In course of construction Dec. 31	978	- -	978
Coke used by operator in blast furnace or affiliated works:			
Quantity.....net tons	31,534,306	1,375,039	32,909,344
Value	$160,668,129	$ 7,149,961	$167,755,090
Disposal of coke:			
Sold for furnace use to affiliated corporations -			
Quantity.....net tons	2,127,176	4,260,028	6,387,204
Value	$ 10,933,119	$20,306,453	$ 31,261,572
Merchant sales of furnace coke -			
Quantity.....net tons	1,566,980	4,156,032	5,723,012
Value	$ 9,800,299	$16,384,006	$ 26,184,305
Sold for foundry use -			
Quantity.....net tons	2,138,017	1,163,660	3,331,677
Value	$ 16,836,376	$ 5,967,936	$ 22,804,312
Sold for domestic use -			
Quantity.....net tons	5,056,568	386,045	5,442,613
Value	$ 37,567,659	$ 2,677,741	$ 40,245,400
Sold for industrial and other use -			
Quantity.....net tons	1,632,837	963,797	2,626,634
Value	$ 12,285,212	$ 4,638,542	$ 16,923,754
Disposal of screenings and breeze:			
Used by operator -			
Quantity.....net tons	3,085,770	52,314	3,138,084
Value	$ 5,595,795	$ 65,034	$ 5,660,830
Sold -			
Quantity.....net tons	936,292	43,516	979,808
Value	$ 3,281,676	$ 167,089	$ 3,448,755
By-products produced:			
Gas.....M cubic feet	706,681,828	- - -	706,681,828
Tar.....gallons	529,486,374	- - -	529,486,374
Ammonium sulphate or equivalent...pounds	1,381,952,369	- - -	1,381,952,369
Crude light oil.....gallons	164,059,552	- - -	164,059,552
Value of by-products sold:			
Gas (surplus)	$ 64,686,800	- - -	$ 64,686,800
Tar	$ 14,103,760	- - -	$ 14,103,760
Ammonium sulphate or equivalent	$ 28,128,203	- - -	$ 28,128,203
Crude light oil and derivatives	$ 27,304,976	- - -	$ 27,304,976

BY-PRODUCT AND BEEHIVE COKE PRODUCED IN THE UNITED STATES, 1926.
(Exclusive of screenings and breeze)

State	By-Product					Beehive				Total	
	Ovens built	Ovens building	Coal used (net tons)	Coke produced (net tons)	Value of coke at ovens	Ovens built	Coal used (net tons)	Coke produced (net tons)	Value of coke at ovens	Coke produced (net tons)	Value of coke at ovens
Alabama	1,276	112	6,799,773	4,779,986	$16,823,492	1,831	(a)	(a)	(a)	(a)	(a)
Colorado	120	- -	859,725	592,939	(b)	1,527	307,011	197,179	(b)	790,118	(b)
Georgia	- -	- -	- - -	- - -	- - -	151	5,125	3,059	$ 23,034	3,059	$ 23,034
Illinois	849	- -	4,712,342	3,336,962	25,050,474	- -	- - -	- - -	- - -	3,336,962	25,050,474
Indiana	1,394	40	7,994,696	5,990,344	44,143,059	- -	- - -	- - -	- - -	5,990,344	44,143,059
Kentucky	108	- -	(a)	(a)	(a)	763	249,952	147,540	600,169	(a)	(a)
Maryland	300	60	1,534,021	1,120,610	(b)	- -	- - -	- - -	- - -	1,120,610	(b)
Massachusetts	466	15	874,053	573,748	(b)	- -	- - -	- - -	- - -	573,748	(b)
Michigan	420	120	2,522,841	1,326,638	12,713,083	- -	- - -	- - -	- - -	1,826,638	12,713,083
Minnesota	220	- -	903,041	619,905	6,014,738	- -	- - -	- - -	- - -	619,905	6,014,738
Missouri	64	- -	(a)	(a)	(a)	- -	- - -	- - -	- - -	(a)	(a)
New Jersey	207	- -	1,260,372	913,250	(b)	- -	- - -	- - -	- - -	913,250	(b)
New Mexico	- -	- -	- - -	- - -	- - -	584	(a)	(a)	(a)	(a)	(a)
New York	661	117	3,950,026	2,827,805	17,455,226	- -	- - -	- - -	- - -	2,827,805	17,455,226
Ohio	1,689	89	10,962,723	7,547,836	40,344,524	204	125,883	84,970	(b)	7,632,806	(b)
Oklanoma	- -	- -	- - -	- - -	- - -	300	- - -	- - -	- - -	- - -	- - -
Pennsylvania	3,126	425	16,895,070	11,200,624	48,722,935	34,375	16,344,439	10,722,352	47,595,184	21,922,976	96,318,119
Rhode Island	40	- -	(a)	(a)	(a)	- -	- - -	- - -	- - -	(a)	(a)
Tennessee	24	- -	165,065	118,624	628,482	1,605	215,647	122,410	605,017	241,034	1,233,499
Utah	33	- -	326,544	184,756	(b)	819	203,750	121,475	1,033,284	306,231	(b)
Virginia	- -	- -	- - -	- - -	- - -	2,914	599,943	370,983	1,716,716	370,983	1,716,716
Washington	20	- -	67,544	42,584	303,624	332	39,265	24,702	214,429	67,286	518,053
West Virginia	411	- -	1,632,790	1,129,862	4,265,884	7,153	957,029	583,599	2,652,219	1,713,461	6,918,103
Wisconsin	262	- -	(a)	(a)	(a)	- -	- - -	- - -	- - -	(a)	(a)
Combined States	- -	- -	2,185,984	1,570,113	11,621,482	- -	176,456	110,682	730,590	6,608,321	29,775,733
Undistributed	- -	- -	- - -	- - -	22,661,530	- -	- - -	- - -	1,854,227	- - -	65,893,565
	11,716	978	63,646,610	44,376,526	250,748,533	52,558	19,224,500	12,488,951	57,024,869	56,865,537	307,773,402

a Included under "Combined States." b Included under "Undistributed."

Final statistics compiled by the Bureau of Mines from reports from all producers of by-product coke in 1926 are given in the following tables.

BY-PRODUCT COKE PRODUCED, USED BY THE PRODUCER, AND SOLD, 1926

State	Produced		Used by producer in blast furnaces, etc.	
	Net tons	Value	Net tons	Value
Alabama	4,779,986	$16,823,492	3,678,770	$12,563,675
Colorado	592,939	(a)	574,075	(a)
Illinois	3,336,962	25,050,474	1,717,860	12,125,822
Indiana	5,990,344	44,143,059	5,293,817	39,182,968
Maryland	1,120,610	(a)	942,663	(a)
Massachusetts	573,748	(a)	14,795	(a)
Michigan	1,826,638	12,713,083	563,236	3,428,735
Minnesota	619,905	6,014,738	282,040	2,732,527
New Jersey	913,250	(a)	76,020	(a)
New York	2,827,805	17,455,226	1,196,574	5,845,404
Ohio	7,547,836	40,344,524	5,914,506	31,073,911
Pennsylvania	11,200,624	48,722,935	9,958,566	41,701,852
Tennessee	118,624	628,482	- - -	- - -
Utah	184,756	(a)	147,657	(a)
Washington	42,584	300,624	32,536	276,731
West Virginia	1,129,862	4,265,884	717,907	2,420,980
Ky.,Mo.,R.I.,and Wis	1,570,113	11,621,482	16,282	130,001
Undistributed	- - -	22,661,530	- - -	9,127,823
	44,376,526	250,748,533	31,334,305	160,606,176

State	Sold for furnace use				Sold for foundry use	
	To affiliated corporations		Merchant sales			
	Net tons	Value	Net tons	Value	Net tons	Value
Alabama	27,840	$141,745	69,085	$308,242	446,438	$2,376,580
Illinois	- - -	- - -	302,578	2,164,339	240,068	2,187,193
Indiana	4,185	29,397	19	147	250,665	2,204,272
Massachusetts	43,570	(a)	- - -	- - -	132,467	(a)
Michigan	74	232	278,654	1,678,625	107,103	959,663
Minnesota	- - -	- - -	- - -	- - -	34,511	362,403
New Jersey	- - -	- - -	- - -	- - -	82,135	(a)
New York	563,767	2,862,765	52,186	997,016	105,581	956,335
Ohio	789,201	4,031,804	205,396	1,167,637	87,519	622,209
Pennsylvania	698,537	3,625,552	142,336	782,923	4,131	23,532
Tennessee	- - -	- - -	- - -	- - -	6,927	46,563
Utah	- - -	- - -	37,322	(a)	- - -	- - -
West Virginia	- - -	- - -	87,738	(a)	155,780	693,664
Ky.,Mo.,R.I.and Wis.	- - -	- - -	351,666	2,262,953	454,707	3,797,232
Undistributed	- - -	263,833	- - -	838,427	- - -	2,596,730
	2,127,176	10,955,119	1,566,980	9,800,209	2,168,017	16,826,376

State	Sold for domestic use		Sold for industrial and other use		Total sales	
	Net tons	Value	Net tons	Value	Net tons	Value
Alabama	153,302	$668,699	108,862	$442,962	804,462	$2,939,228
Colorado	- - -	- - -	18,285	(a)	18,985	(a)
Illinois	853,866	6,247,920	255,804	2,252,924	1,632,316	12,852,376
Indiana	298,041	1,678,543	119,761	847,473	672,671	4,759,732
Maryland	52,106	(a)	121,135	(a)	173,241	(a)
Massachusetts	319,478	(a)	- - -	- - -	555,517	(a)
Michigan	741,249	5,611,961	26,671	226,851	1,153,751	8,477,333
Minnesota	304,842	2,964,938	8,865	79,108	348,216	3,406,447
New Jersey	198,471	(a)	549,632	(a)	820,286	(a)
New York	589,964	5,075,972	210,201	1,597,589	1,561,699	11,089,967
Ohio	458,783	2,969,357	39,395	241,561	1,581,294	9,042,256
Pennsylvania	320,658	2,152,438	66,556	377,559	1,232,218	6,962,004
Tennessee	9,351	47,403	93,195	512,024	114,473	606,990
Utah	- - -	- - -	- - -	- - -	37,322	(a)
Washington	3,855	32,793	- - -	- - -	3,855	32,793
West Virginia	84,428	282,869	4,469	30,054	332,415	(a)
Ky.,Mo.,R.I.and Wis.	678,174	5,025,112	54,306	365,853	1,538,853	11,451,150
Undistributed	- - -	4,802,656	- - -	5,310,154	- - -	14,824,387
	5,056,568	37,567,692	1,862,837	12,285,212	12,581,578	87,444,665

a Included under "Undistributed."

PRODUCTION OF COKE AND BY-PRODUCTS in 1926 - continued

There were 78 by-product plants that produced coke in 1926. Of these 49 were affiliated with iron furnaces, and 29 were non-furnace plants. The output of the furnace plants was 82.7 per cent of the total as against 83.2 per cent in 1925 and 73.5 per cent in 1913.

NUMBER AND PRODUCTION OF BY-PRODUCT COKE PLANTS CONNECTED WITH IRON FURNACES AND OF ALL OTHER PLANTS, 1913 - 1926

Year	Number of active plants		Coke produced (net tons)		Percentage of production	
	Furnace plants	Other plants	Furnace plants	Other plants	Furnace plants	Other plants
1913	21	15	9,546,855	3,367,845	73.5	26.5
1914	23	14	8,059,727	3,190,216	71.6	28.4
1915	24	16	10,448,015	3,624,880	74.2	25.8
1916	29	17	14,476,576	4,632,785	75.8	24.2
1917	33	19	17,321,145	5,118,135	77.2	22.8
1918	39	21	20,124,218	5,873,362	77.4	22.6
1919	43	22	20,019,097	5,118,524	79.6	20.4
1920	45	23	25,212,745	5,621,206	81.8	18.2
1921	45	22	16,231,374	3,518,206	82.2	17.8
1922	43	21	23,589,702	4,660,843	83.7	16.3
1923	44	21	31,117,323	6,480,341	82.8	17.2
1924	47	24	28,165,902	5,817,666	82.9	17.1
1925	48	26	33,206,442	6,703,717	83.2	16.8
1926	49	29	36,702,890	7,673,696	82.7	17.3

The final returns of the by-products recovered in 1926 are tabulated below. These figures include all by-products except coke breeze.

BY-PRODUCTS OBTAINED FROM COKE-OVEN OPERATIONS IN 1926

Product	Unit	Production	Sales		
			Quantity	Value	
				Total	Average
Tar	Gallons	529,486,374	277,348,522	$14,103,700	$0.051
Ammonia:					
Sulphate	Pounds	1,167,859,453	1,152,141,717	24,658,031	.021
Ammonia liquor (NH_3 content)	do	53,523,229	53,448,034	3,470,172	.065
		- - - -	- - - -	28,128,203	- -
Sulphate equivalent of all forms	do	1,381,902,369	1,365,933,751	- - - -	- -
Gas:					
Used under boilers, etc.	M.cu.ft.		25,953,876	1,436,699	.055
Used in steel or affiliated plants	do	a/706,681,828	249,840,649	27,955,574	.112
Distributed through city mains	do		69,565,953	29,978,997	.335
Sold for industrial use	do		32,553,610	5,313,530	.163
			397,914,088	64,686,800	.163
Light oil and derivatives:					
Crude light oil	Gallons	b/164,059,552	10,783,568	1,330,208	.123
Benzol, crude	do	4,744,713	4,660,621	1,109,974	.238
refined	do	17,713,904	17,327,169	3,957,719	.228
Motor benzol	do	90,029,972	89,501,212	16,863,109	.188
Toluol, crude	do	432,317	400,308	127,298	.318
refined	do	8,359,135	8,250,297	2,787,454	.338
Solvent naphtha	do	4,704,555	3,546,117	1,035,870	.292
Other light oil products	do	127,710	1,384,306	93,344	.070
		c/30,112,306	135,793,595	27,304,976	.201
Naphthalene:					
Crude	Pounds	7,746,821	7,556,372	96,210	.013
Refined	do	139,701	166,851	1,100	.007
		7,886,522	7,723,223	97,310	.013
Other products		- - - -	- - - -	148,720	- -
Value of all by-products sold		- - - -	- - - -	d/134,469,769	- -

a Includes gas wasted and gas used for heating retorts.
b Refined on the premises to make the derived products shown, 159,589,756 gallons.
c Total gallons of derived products. d Exclusive of the value of breeze production.

YIELD AND UNIT VALUES OF COKE-OVEN BY-PRODUCTS

AVERAGE YIELD OF COKE AND BY-PRODUCTS PER NET TON OF COAL CHARGED IN BY-PRODUCT OVENS IN THE UNITED STATES, 1915 and 1919-1926.

Product	Unit	1915	1919	1920	1921	1922	1923	1924	1925	1926
Coke	Pounds	1,440	1,402	1,395	1,376	1,390	1,386	1,386	1,398	1,394
Tar	gallons	7.1	8.1	8.2	8.8	8.0	8.1	8.6	8.4	8.3
Ammonium sulphate (or equivalent)	pounds	20.1	20.8	21.4	22.8	21.9	21.2	22.2	22.4	21.7
Light oil	gallons	1.5	2.7	a2.7	a2.8	a2.7	a2.7	a2.9	a2.9	a2.8
Gas:										
Total	M.cu.ft.	11.0	11.6	10.8	10.8	10.8	11.1	11.0	11.2	11.1
Surplus sold or used	do	4.3	5.4	5.2	5.4	5.6	5.9	6.1	6.3	6.3
Burned in coking process	do	6.3	5.9	5.4	5.1	5.0	5.0	4.7	4.7	4.6
Wasted	do	.4	.3	.2	.3	.2	.2	.2	.2	.2

a Average for plants now recovering light oil.

VALUE OF BY-PRODUCTS AND OF COKE, INCLUDING BREEZE, PER TON OF COKE PRODUCED IN THE UNITED STATES, 1915 and 1919-1926

Product	1915	1919	1920	1921	1922	1923	1924	1925	1926
Ammonia and its compounds	$0.70	$1.06	$1.16	$0.94	$0.78	$0.84	$0.80	$0.69	$0.63
Light oil and its derivatives (including naphthalene)	.52	.50	.61	.59	.55	.61	.50	.54	.62
Surplus gas sold or used	.61	.66	1.05	1.31	1.33	1.37	1.46	1.54	1.46
Tar sold	.25	.28	.21	.29	.22	.25	.28	.30	.32
Miscellaneous products	.03	.03	.01	.01	.01	.01	--	--	--
	2.11	2.53	3.04	3.04	2.91	2.98	3.04	3.07	3.03
Tar used, not sold	(a)	.09	.22	.26	.23	.25	.29	.29	.29
Breeze produced	(b)	.10	.14	.16	.13	.24	.18	.22	.21
Total value of by-products including those not sold	2.19	2.72	3.40	3.46	3.32	3.48	3.51	3.58	3.53
Value of coke produced	3.45	c6.37	c10.15	c5.95	c6.59	c6.85	c6.76	c5.28	c5.65
Total value of coke and by-products	5.64	9.09	13.55	9.41	9.91	10.33	9.27	8.86	9.18

a Included in tar sold. b Estimate included in total. c The average receipts per ton of coke sold during these years were $6.58 in 1919, $10.77 in 1920, $7.72 in 1921, $8.48 in 1922, $8.33 in 1923, $6.90 in 1924, $6.61 in 1925 and $6.95 in 1926.

AVERAGE RECEIPTS PER UNIT OF COKE-OVEN BY-PRODUCTS SOLD, 1913-1926

	Tar	Sulphate	Surplus gas	Benzol refined	Motor benzol	Toluol refined	Solvent naphtha	Naphthalene Crude	Naphthalene Refined
Unit	Gallon	Pound	M.cu.ft.	Gallon	Gallon	Gallon	Gallon	Pound	Pound
	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	
1913	2.5	3.1	8.6	a27	(b)	a$0.29	a25	(b)	
1914	2.6	2.8	9.8	a25	(b)	a .33	a25	(b)	
1915	2.8	2.8	10.2	56.8	(c)	2.45	24.0	d10.0	
1917	2.7	3.4	8.7	43.0	(c)	1.37	15.6	e 3.3	
1918	3.2	4.5	8.7	27.5	(c)	1.43	14.1	2.8	6.6
1919	3.2	3.8	8.6	20.6	(e)	.265	15.2	2.0	4.1
1920	3.7	4.3	14.0	26.0	22.7	.300	18.1	2.7	6.1
1921	4.2	2.5	16.8	23.9	16.6	.283	17.7	2.5	5.5
1922	4.0	2.5	16.7	28.5	19.2	.292	18.8	1.6	5.0
1923	4.4	2.9	16.2	24.8	16.3	.291	17.9	1.7	5.5
1924	4.6	2.4	16.5	20.9	15.2	.238	18.7	1.5	3.6
1925	4.9	2.3	17.0	22.4	16.6	.261	20.2	1.0	2.5
1926	5.1	2.1	16.5	22.8	18.8	.338	29.2	1.3	(f)

a Trade quotations, New York market; used to avoid disclosing individual operators' reports. b No data. c Not reported during the war. d Crude and refined not separated prior to 1918. e Data uncertain. f Sales too small to be representative.

DISPOSAL OF COKE-OVEN TAR PRODUCED IN THE UNITED STATES, 1925 and 1926, IN GALLONS

	Furnace plants	Other plants	Total
1925			
Sold	162,633,721	77,527,265	240,160,986
Used:			
As fuel under boilers	4,974,384	- - - -	4,974,384
In open-hearth or other metallurgical plants	228,319,084	- - - -	228,319,084
1926			
Sold	189,863,460	87,385,062	277,248,522
Used:			
As fuel under boilers	8,003,465	- - - -	8,003,465
In open-hearth or other metallurgical plants	250,834,296	- - - -	250,834,296

DISPOSITION OF GAS FROM BY-PRODUCT OVENS IN THE UNITED STATES, 1925 and 1926.

	Millions of cubic feet	Per centage of total production	Value Total	Value Cents per M
1925				
Used under boilers	28,239	3.9	$1,451,253	5.7
Used in steel or other related plants	230,030	31.0	26,380,657	11.5
Distributed through city mains	77,457	10.1	29,319,309	37.9
Sold for industrial purposes	26,528	3.6	4,333,000	14.7
Total sold or used (not for ovens)	362,204	48.6	61,484,219	17.0
Used in heating ovens	236,112	31.6	- - - -	----
Wasted	11,278	1.8	- - - -	----
Total produced	609,644	100.0	- - - -	----
1926				
Used under boilers	25,954	3.7	1,438,699	5.5
Used in steel or other related plants	242,841	33.3	27,355,574	11.2
Distributed through city mains	98,566	13.7	29,978,997	33.5
Sold for industrial purposes	32,552	4.5	5,313,530	16.3
Total sold or used (not for ovens)	397,914	56.3	64,666,800	16.3
Used in heating ovens	296,431	42.9	- - - -	----
Wasted	12,837	1.8	- - - -	----
Total produced	726,882	100.0	- - - -	----

AVERAGE RECEIPTS PER TON FROM SALES OF COKE AND BREEZE, 1918 - 1926

	1918	1919	1920	1921	1922	1923	1924	1925	1926
By-product coke:									
Sold for furnace use a	$7.42	$6.63	$10.57	$6.62	$7.03	$6.74	$5.73	$5.73	$6.25
Sold for foundry use	9.72	8.69	13.80	10.41	9.94	10.54	8.64	7.98	7.77
Sold for domestic use	7.45	5.41	8.03	8.22	8.30	9.05	7.13	6.98	7.43
Sold for other industrial use						8.06	7.62	7.16	7.39
Beehive coke:									
Sold for furnace use a	5.33	4.94	7.17	5.30	5.52	6.11	4.02	4.04	3.94
Sold for foundry use	7.53	6.20	9.52	8.37	7.15	7.30	5.53	5.18	5.13
Sold for domestic use	6.27	5.39	8.04	4.79	6.04	4.82	3.64	5.71	6.94
Sold for other industrial use						6.37	4.05	4.35	4.81
Coke breeze:									
By-product	(b)	(c)	3.22	2.30	3.32	3.94	2.78	3.58	3.50

a Figures for 1918-1922 represent total sales including those to affiliated corporations. Beginning with 1923 they represent merchant sales only. b No data. c Included with sales of domestic and other coke.

Some Modern Types of Steel Mill Cranes

By W. D. KELLER*

THE development of cranes for the steel mill has kept pace with other improvements in the steel industry. This development was made possible by the co-operation of the steel mill engineer and the crane builder.

Efforts have been made to reduce hazard by safe guarding the crane in every possible respect, and the necessity of reducing production costs of steel dictates the maximum in reliability and the minimum in maintenance.

Steel mill service requires a crane of heavy rigid construction, and the one piece trolley design featured by the Alliance Machine Company has met with much favor. In this design the trolley sides, connecting frame, and bearing brackets are contained in one steel casting, making the most rigid construction possible, with nothing to work loose or get out of line. The one piece trolley is applicable to all classes of cranes and is much used for heavy standard types, as well as for special machines such as Soaking Pit cranes and open hearth chargers.

Hardened and heat treated gears and pinions are being quite largely used, greatly increasing the life of those vital parts. Steel drums are also being used to a considerable extent. There is a difference of opinion among steel mill engineers as to the comparative effects of steel and iron drums on the life of the hoisting cables, and definite data on this subject would be of interest to both the manufacturer and the user.

The crane safety requirements of the steel industry are well understood and will be mentioned only in so far as they affect modern crane design.

Over hung gears have been practically eliminated from the modern crane, and we note the development from the exposed gear to the guard, and finally to the totally enclosing case, preferably oil

*Designing Engineer, Alliance Machine Co.

tight, affording both protection for safety and lubrication for long life.

The possibility of running the gears in an oil bath leads to a consideration of the worm gear as a means of speed reduction.

The worm gear was formerly considered an unreliable and inefficient mechanism, to be employed only when no other speed reducing means could be used to advantage. There were, however, some noteworthy successful applications, indicating possibilities for general use.

The automotive engineers recognizing this possibility, and the necessity of a reliable, compact, right angle, high reduction unit for the rear axle drive for motor trucks, developed the modern type of worm gearing, using a hardened and ground steel worm and a bronze worm wheel.

The success of this drive, due to proper design and materials, under the severe service of motor truck usage, led to the development of a similar type for general commercial use, and to a serious consideration and investigation by the engineers of the steel mills and the crane manufacturers, as to whether the modern type of worm gear reduction was suitable for crane usage. The result has been a marked change in attitude by the engineers, and their recommendation, in many cases, of the worm drive in preference to other established types of gear reductions.

It was found that, except in the case of extreme reductions, if proper design, materials, and workmanship were used, the efficiency of the worm gearing was greater than that of ordinary spur gearing giving equal reductions, and that longer life and lower maintenance were to be expected. The results have justified these expectations.

The efficiency of the worm gear is of course dependant on the helical angle of the worm thread, and as dynamic braking is usually used in the hoist motion of a crane this point must be given consideration.

Extreme reductions should be avoided as the efficiency decreases rapidly and, as the helical angle becomes small, there is a tendency toward self-locking which might prevent the load from overhauling the gearing.

For crane usage the worm can be placed either above or below the worm wheel with equally satisfactory results.

The first installation of the modern type of worm gear made by our company was 21 units on car dumping and vessel loading equipment for the Virginian R. R. at Norfolk. This was put into service in 1924 and has given perfect satisfaction.

The first crane installation made by our company was at the Ford Motor Company's plant in 1925 and has given equally satisfactory service.

Notable installations using the modern type of worm gear which are being, or have recently been made by our company are as follows:

Timken Roller Bearing Company—One 165-ton Ladle crane with worm driven main hoist, and one 5-ton low floor type open hearth charging machine, having a worm drive on the hoist and trolley travel. This latter service is recognized as being the most severe encountered in steel mill crane usage and the worm gear is standing up under this abuse in a perfectly satisfactory manner. An important feature of this charging machine is that the use of worm gears permits such an arrangement of gearing and motors as to give the operator an absolutely unobstructed view of the entire charging floor and furnaces.

Carnegie Steel Company (Ohio Works)—Three 160-ton ladle cranes with worm driven main hoist, and two 7½-ton high type Soaking Pit cranes equipped with worm drives on the hoist, tongs revolving and tongs opening motions.

Carnegie Steel Company (Duquesne Works)—Three 175-ton ladle cranes having a worm driven main hoist.

American Steel and Wire Company—One 75-ton ladle crane, the hoist and travel motions of each trolley being worm driven.

These ladle cranes are all of the four girder, two trolley type. The main trolleys having two drums placed parallel with each other near the center of the trolley, the drum gears intermeshing, thus preventing the load from being dropped in case of breakage of a drum pinion or intermediate shaft. This feature is patented by our company, who has other patents pending on this worm driven trolley.

The cables are reeved from the outside of the drums, thus affording a clearance space under the main trolley for the auxiliary girders and trolley.

The drum pinion shafts are placed outside the drums toward the ends of the trolley, and a worm gear is mounted near the end of each, the two gears being in line with each other.

The 75-ton crane has one hoist motor which is located between the worm gears at right angles to the drums and shafts. The ends of the motor armature shaft are connected by means of flexible couplings to right and left hand worms meshing with the worm gears. These couplings provide a means of adjustment where by it is possible to so set the gearing that there will be no working contact between the drum gears in the normal operation of the crane, the intermeshing feature being retained only as a safety provision. This adjustment is readily made when installing the motor, is permanent and tends to reduce vibration.

An electric brake is provided on each worm, either brake being sufficient to hold the maximum load.

The upper sheaves are located so as to be accessible from the top of the trolley to facilitate the reeving of the cables.

The construction of the main trolleys on the larger cranes is identical, except that two motors are used, one located outside of each worm gear and the two worms are connected by means of a shaft and flexible couplings. Each motor is large enough to handle the load independently of the other, and in case one is disabled it can be disconnected at the coupling and the hoist operated by means of the other without increasing the stresses in the gearing.

These cranes are all completely equipped with anti-friction bearings. This practice is becoming quite general in the case of steel mill cranes, principally on account of the decreased maintenance charges following their use. A crane equipped in the usual manner with bronze bushings requires

frequent lubrication and such bearings are difficult to seal against oil leakage and dirt entrance. Anti-friction bearings are readily sealed and require lubricating attention only at long intervals.

When anti-friction bearings are used particular care should be taken to preserve alignment. On the cranes above mentioned this is done by boring the bearings in line at one setting and by using flexible couplings and self-aligning bearings where there is a chance of misalignment due to deflection or other causes.

No complete test reports on power consumption are as yet available. However, electric power is usually a by-product of a steel plant and the economies in its consumption effected by the use of anti-friction bearings is in most cases of no great importance. It would appear however, that in many cases the size of the bridge and trolley travel motors could be decreased under that usually required for plain bearings. Tests made on the erecting floor of our company show that a force of 10 pounds applied at a radius of 12″ on the armature shaft of the cross travel motor was sufficient to put into motion the completed 175-ton trolley.

The effect of the friction at the sheaves in the case of ladle and other cranes having a large rope reduction, is sometimes overlooked. This friction in addition to the power required to bend the cable around the sheave, builds up the cable load by a certain percentage of increment at each pass, so that the stresses in the lead lines to the drum are appreciably greater than those at the opposite or dead end of the cable. This condition is relieved to a considerable extent by the use of anti-friction bearings in the sheaves.

Indications point to a more extended use of both anti-friction bearings and worm gearing for steel mill cranes, particularly in reference to ladle trolleys, where their use permits a more simple and accessible design, compensation for mis-alignment due to deflection and a known and uniform distribution of loading to all parts, resulting in an absence of unknown stresses due to such causes.

The excellent results which these cranes are giving indicate that our company, who first developed the four girder ladle crane and the interlocked gear type of ladle trolley, have made another valuable contribution to the steel industry.

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*Electrical Safety Circuits—Their Uses and Construction**

By W. M. RUNYON†

IN order that we may the more readily keep from confusing the subject of Safety Circuits with that of the more general and very loosely used phrases of "grounding," "grounded," "ground circuits," etc., it will be well to define just what is intended to be conveyed by the term "Safety Circuits."

The term "grounded," as commonly used, has several meanings, most of which are not particularly definite. It is very often used to describe a break down in the insulation of a piece of equipment; thus, we say a motor has grounded, meaning that the insulation has broken down, allowing a conductor to come into contact with the motor frame, and this irrespective of whether or not the frame is itself connected to the earth. We drive a rod into the ground, and we call it a ground. As you know, some repairmen have a rule something like this: "If you find a lighting circuit grounded, reverse the leads. This will put the ground on the grounded side and eliminate the ground."

There are many kinds of ground circuits which are not safety circuits, but which are employed for entirely different purposes, such, for instance, as the power grounds used in generating and sub-stations for grounding the neutrals of transmission systems, lightning arrestor ground connections, railway return systems, earth return circuits for telephone, telegraph and other communication and signaling systems, railroad lock signal systems, wireless equipment, etc.

By a safety circuit we mean a circuit which is installed for the sole purpose of reducing the shock hazard or the fire hazard, or both, which are incidental to the use of electricity. Such circuits are not intended to be used for carrying the working currents of the system and they function only when some abnormal condition arises, and usually for but very short periods.

The generation, transmission, distribution and utilization of electricity is accompanied, unfortunately, by a considerable hazard in the form of danger to human beings from electric shock, and this we term the "shock hazard." Even a very slight shock, while not in itself harmful, may at times result seriously by causing the workman to lose his balance while working in a dangerous position, or to cause a sudden and uncontrolled movement of some part of the body, which may result in bringing tools or parts of the body into contact with live parts of a circuit, which may present a more serious hazard.

Aside from the humanitarian aspect of the matter, an electrical shock generally results in a serious loss of self-confidence on the part of the person shocked and, if serious, usually means a decided slowing down of production in the entire Department, often for days.

The shock hazard is due to the fact that if a person who is in contact with the earth, either directly by standing upon it or indirectly by being in contact with some metal body which is connected with the earth, such as a water or gas pipe, the steel frame of

*Presented before Phila. Section, A.I.&S.E.E., Dec. 3, 1927

†Crouse-Hinds Company, Syracuse, N. Y.

a building, etc., touches an uninsulated part of an electric circuit, more or less current will pass through the body to the earth, the amount of current and, therefore, the severity of the shock, depending upon the difference of voltage between the part touched and the earth, and also upon the character of the contact which is made with the live part and with the earth. If the contact with the earth is "good," for instance, if a person is standing upon a wet dirt floor and has wet feet, or has hold of a water faucet or other metal work, the connections are good enough to cause a very serious shock, even when the voltage between the circuit and the earth is only 110 volts. Under such conditions, to touch a 2,200 volt circuit would almost always be fatal.

Shock hazard falls quite naturally into two groups: High voltage and low voltage.

The high voltage hazard is the result of the possibility of the higher voltages of a transmission or distribution system being imposed upon the low voltage wiring systems, due to the breaking down of a transformer, the crossing of high and low tension wires, etc. It is evident that this dangerous condition exists only under abnormal conditions and while such conditions exist only infrequently, they are, of course, very serious when they do exist.

The low voltage hazard, on the other hand, exists all the time; that is to say, a person is always subject to a certain amount of shock when coming into contact with certain of the conductors of the utilization circuits, and while, with proper protective measures, the shock voltage may be limited to about 110 volts, the cumulative hazard is very considerable because of the fact that it is always present throughout the entire wiring system.

The high voltage hazard is much greater in residential and commercial districts where the wires are run overhead and where the low and high voltage lines are carried upon the same poles over a large territory, through trees, etc. In industrial establishments, particularly the larger ones, having transformers installed on the premises, the chance of a cross between a high and low tension wire is reduced to a minimum, and about the only possibility of getting high voltage is through a break down in the transformer. However, the low voltage hazard is much more serious than in residential or commercial fields due to several factors, perhaps the principal one being the use of portable tools, hand lamps, etc., under conditions where a break down of the insulation is almost sure to result in a more or less serious shock owing to the good conductive conditions which generally prevail.

A safety circuit connected to one of the conductors of the wiring system to which the motors, lights and other utilization equipment is connected is undoubtedly the best and, in fact, about the only method we have of protecting against the high voltage hazard.

The Safety Circuit as such was first suggested by Professor Elihu Thompson. Strange as it may seem, there has been, until the last few years, very little change in safety circuit construction from that which was used during the early years of the electrical industry. This is the more astonishing when we stop to consider the fact that in the earlier days a 2,200 volt circuit was the highest we had to deal with, whereas today it is not at all uncommon to find 33,000 volt lines on the public highways and transmission systems of voltages up to 220,000 volts are now being used and these, while not on public highways, necessarily cross the highways here and there and often cross over the lower voltage systems. Furthermore, the amount of current which could be drawn through a short circuit on the older systems was generally limited, due to the fact that the transformers were much smaller and even the generating stations themselves had not the capacity to furnish as much current as is today taken by many individual customers. A dead ground on some of our present day systems may mean almost anything in the way of current volume and explosive force.

Perhaps the most important change, however, is the tremendous increase in the diversity of use and in the ramifications of our present-day electrical systems. The electrical devices in use and the various applications of electricity are too numerous to mention here, but with the general adaptation of electrical service to our every day needs in the home, office, store and factory, there has necessarily come a great increase in the possibilities of electrical shock and furthermore a serious, although somewhat natural, disregard upon the part of the user for the hazards involved, because familiarity breeds contempt.

This tremendous growth and the changed conditions not only make adequate safety circuit construction imperative, but they make it increasingly difficult to obtain, because it is obvious that a safety circuit which might furnish adequate protection on a localized system of small capacity, such as prevailed twenty years ago, might easily be entirely inadequate under present day conditions. In spite of all these changes and while there has been a great deal of improvement in wiring methods generally, there has been, until very recently, no corresponding improvement in the construction of Safety Circuits.

It is well to note that State Labor Bureaus and Industrial Commissions are beginning to take serious notice of the shock hazard in industry and are beginning to formulate regulations of their own, as they feel that the existing codes or, at least, the results that they are obtaining from the existing codes, do not furnish sufficient protection, and this is not to be wondered at when it is possible for three men to be killed in as many minutes from a single portable machine, as recently happened in New Jersey. Such accidents can undoubtedly be prevented by proper safety circuit construction. In at least one instance an effort has been made to put through legislation which would make some one criminally liable for accidents when inadequate protection is provided.

While a properly constructed safety circuit applied to one of the conductors of the wiring system practically eliminates the high voltage hazard, it does not eliminate the low voltage hazard, and in fact, has sometimes been said to be responsible for the low voltage hazard. The fact is, however, that the low voltage system should have one wire connected to earth, even if no high voltage hazard exists at all, because it actually results in decreasing the low voltage hazard. Most systems are 3-wire; that is, 110 volts between each of two outside wires and a neutral, and with 220 volts between the two outside

wires. While only two of the three wires are often used for small installations, it does not alter the fact that the third wire is connected with the system and is used for some other installation not far away.

Now, if a safety circuit is attached to the neutral or central wire, the voltage between either of the other two wires and the earth will be limited to approximately 110 volts, but if no safety circuit is employed and one of the outside wires become accidentally grounded, which is bound to happen sooner or later, then there will be a voltage of 110 between the neutral wire and the earth, and a voltage of 220 between the other wire and the earth, and the resulting hazard will be perhaps five or six times as great as it would be had a safety circuit been used. Furthermore, when accidental grounds occur, a safety circuit usually results in the fuses being blown and the trouble being consequently corrected before any serious fire hazard is created.

We may well say, therefore, that the low voltage hazard, like the poor, we will always have with us. How then may it be reduced to a minimum?

With one wire connected directly and adequately to the earth by means of a safety circuit, there can be no difference of potential between that wire and the earth, so that no shock would be received by anyone **touching that wire** or any metal parts connected to that wire. This is the basis for the "polarzied" system of wiring, which construction is now standard practice in most localities. In the "polarized" system of wiring, the wires themselves are identified by colors, one conductor being made white throughout the entire system, while the other conductors are generally black. The white wires are always connected together and it is to this wire that the safety circuit is connected, the connection being made at the main switch. It is very important that no fuses and no switches be installed in the white wire. When a two-wire branch circuit is taken off, the white wire is connected through solid, a fuse and switch being used in the black wire only. Obviously this method of wiring is considerably cheaper than the old type.

Practically all wiring devices are now being manufactured with identified terminals; that is, one terminal is marked with a white coloring, and this terminal, of course, must always be connected to the white wire. For instance, in the ordinary screw shell socket, the screw portion is connected to the white wire, while the black wire connects to the small center post in the base of the socket and, as you know, it is practically impossible for one to get into contact with this stud in the bottom of the socket, while it is comparatively easy to come into contact with the screw shell or with the base of a lamp which is screwed into the shell, but since this part is connected to the white wire, and as the white wire is equipped with a safety circuit, no shock will result from making this kind of contact. The same general scheme is carried out throughout the whole system or, in other words, the live or dangerous wire is kept on the inside of all fittings, etc., where it is more difficult for anyone to come into contact with it.

With the wiring system properly identified and polarized, including, of course, single pole fusing and switching, the permanent low voltage hazard is pretty well taken care of; but we still have the hazard resulting from the breaking down of the insulation in a conduit or other metal wire way, or in a motor or other piece of metal enclosed equipment, because when such a break down occurs, there immediately is established a difference of potential between the metal parts involved and the earth, and of course anyone touching these parts becomes subject to shock. This hazard, however, may be easily and quite completely eliminated by applying a safety circuit to all such metal enclosures, or, as we commonly say, all such enclosures should be grounded, which is carried out by connecting these parts to earth by various means, which I will describe somewhat a little later.

In designing and installing safety circuits the following features should be given careful consideration; and I will point out to you how these features are incorporated in the particular safety circuit con-

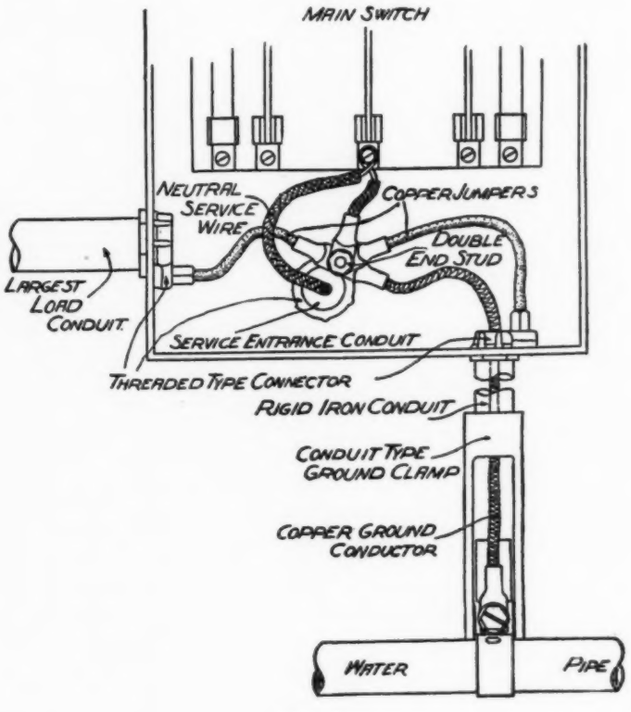


FIG. 1.

struction shown in Fig. 1. This chart shows a safety circuit applied to the main switch of a 2 or 3-wire lighting system.

(1) It should create no fire hazard in itself.

(2) The connections should be so arranged that when a burnout occurs, due to one of the ungrounded service wires coming in contact with the service entrance conduit, the ground connection for the conduit itself will not be injured.

(3) The circuit should proved a proper path for both high and low frequency currents and also for direct current.

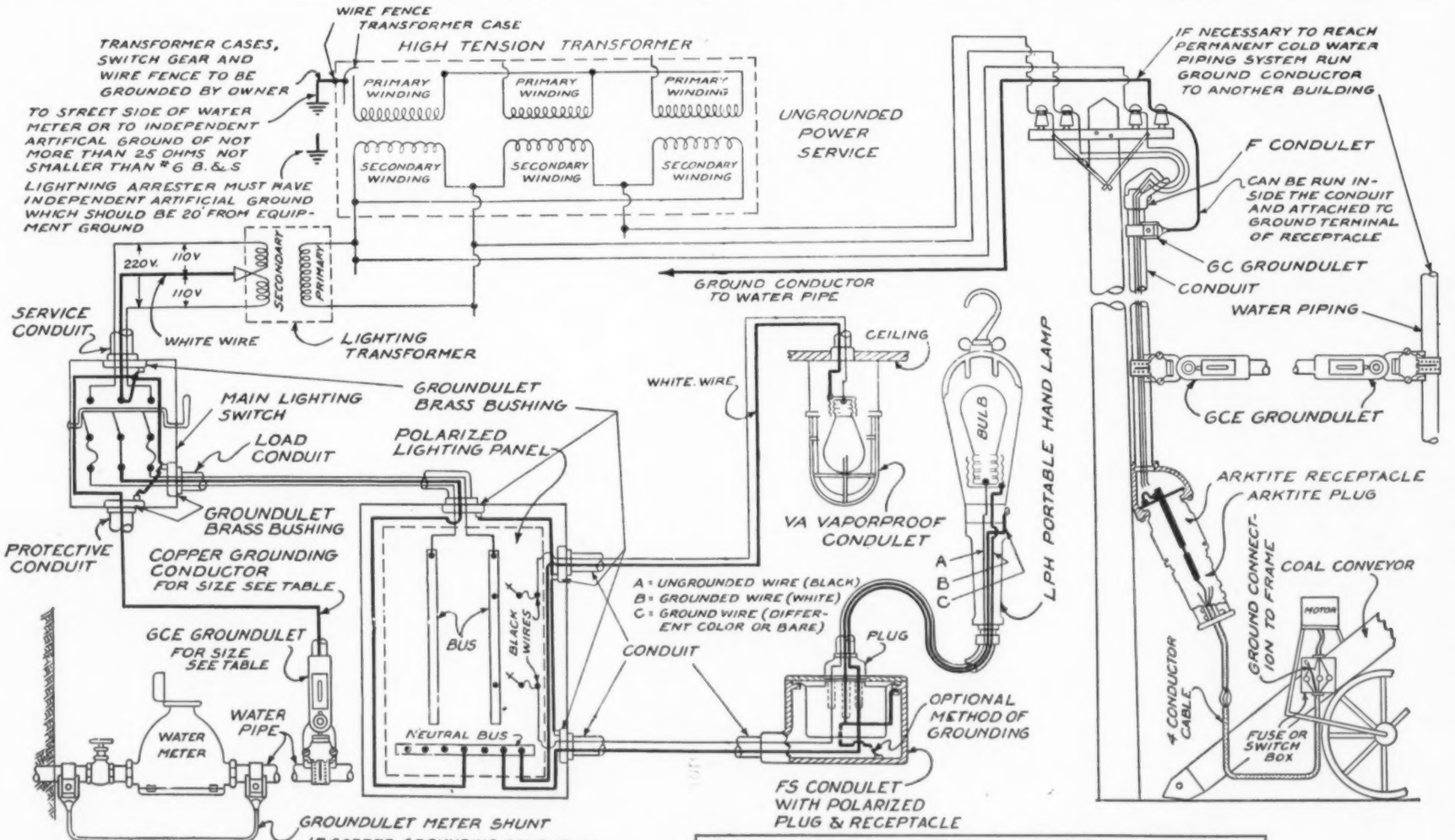
(4) The circuit should have as low resistance and impedence and as high carrying capacity as a reasonable cost will permit.

(5) It should be fully protected against mechanical injury.

INDUSTRIAL INSTALLATION

UNGROUNDED POWER SERVICE, GROUNDED AND POLARIZED LIGHTING AND APPLIANCE CIRCUITS

FRAMES OR ENCLOSURES OF PORTABLE APPLIANCES AND PORTABLE MOTORS GROUNDED



SERVICE CONDUIT	COPPER CONDUCTOR B.&S	COPPER JUMPERS	PROTECTIVE CONDUIT	GROUND FITTINGS
1/2"-2"	NO. 8	NO. 8	1/2"	1/2" SINGLE STRAP
2 1/2"	NO. 6	NO. 6	1/2"	1/2" SINGLE STRAP
3"	NO. 4	NO. 4	3/4"	3/4" TWO STRAP
3 1/2"	NO. 2	NO. 4	3/4"	3/4" TWO STRAP
4"-6"	NO. 0	NO. 2	1"	1" THREE STRAP

FIG. 2.

(6) All connections should be at least as good as those employed for other electrical circuits and must have ample carrying capacity.

(7) The construction should be such that its application need not be limited to any particular locality or conditions.

(8) The construction should conform to the requirements of the National Electrical Code.

On this larger chart, Fig. 2, we have tried to show suitable safety circuits for the metal enclosures of different types of electrical equipment, including portable tools and devices, and I will run over the different installations briefly.

The National Electrical Code covers quite fully safety circuit construction or grounding for circuits and equipment below 750 volts, and the National Electrical Safety Code of the United States Bureau of Standards goes somewhat more into the higher voltages, but more particularly in connection with public utility generating and sub-station equipment.

We have today in our larger industrial establishments and particularly, perhaps, in our steel plants, considerable high voltage equipment, this including not only step-down transformer equipment but high voltage motors, as the use of 2,300 and 6,600 volt motors is becoming quite common. Furthermore this equipment is very closely associated with lower voltage equipment, sometimes alternating and sometimes direct current, and it is not uncommon to find such combinations as a 6,600 volt motor and its control equipment installed within a few feet of 220 or 550 volt direct current motors.

The proper safety circuit construction for this higher voltage equipment should follow very closely the practice of the electrical utilities in their generating and substation grounding. In carrying out this class of grounding, all of the equipment and circuits below 750 volts is generally connected to the piping of a water supply system when such is available. Lightning arrestors are generally attached to an individual artificial ground, consisting of a single pipe or rod driven to permanent moisture, while the circuits and equipment above 750 volts are connected to what is commonly called a "ground mat" or "grid." This is constructed by driving several pipes or rods into the ground, and connecting them together by heavy cables. In the case of a large generating or sub-station, these cables may be one-half million or one million circular mills, but for an individual installation, say of two or three thousand killowatts or less, a 4/0 cable is generally used, and inch and a quarter pipe or one-inch copper-weld rods.

As a rule, not less than four pipes are driven, and these generally are located roughly at the corners of the area to be protected and when these are connected together and cross-connections are made to the various pieces of equipment, the entire protected area is then floating on a "mat or grid" consisting of these cables which usually are buried six inches to a foot below the ground.

Generally speaking, the lightning arrestor connection should not be tied in to this grid nor should the grid be tied in with the water piping or gas piping because of the possibility of high resistance joints in the water pipes or mains, but if there is a water faucet within ten feet of a high tension grid, it is advisable to connect it to the grid, otherwise it may in itself present a serious hazard.

Sufficient pipes must be driven and to a sufficient depth to secure a resistance not much in excess of about 3 ohms. The resistance will vary approximately inversely with the number of pipes driven, providing the pipes are kept at least ten feet apart. The pipes should be equipped with drive points and suitable ground heads. The ground heads should be preferably of bronze to resist corrosion, and should be of a disconnecting type to facilitate periodic testing. Suitable fittings for this work and light portable testing meters are available, and full testing information may be obtained from any of the three or four different manufacturers making this type of meter.

In closing, I would suggest that in studying this phase of your safety work, either as such or in connection with your electrical engineering, that you avail yourselves of expert advice on the subject so far as the general layout is concerned. So far as the construction work itself goes, any competent wire man or plant electrician can readily handle the situation.

The work of the National Safety Council, which council was born at the Milwaukee Convention of the Association of Iron and Steel Electrical Engineers in 1912, and that of many other Safety Committees, is well and favorably known. They have accomplished much in the way of accident prevention by means of the enclosed safety switch, the use of guards, the proper enclosure of live parts, etc., but the shock hazard from metal enclosures still remains a serious and ever-increasing one and considerably more thought and attention can well be given to this matter, especially in connection with portable equipment, and in fact must be given to it if the industry is to maintain a reasonably high standard in Accident Prevention work.

FLOOR PLANS
For
IRON and STEEL EXPOSITION
Will be placed in the mails within a very short time

Items of Interest

2531 Men
Two Hundred and Seventeen Days
4,324,236 Hours
No Lost Time Accidents
Over Seven Months of Perfect Record Attained at Joliet Works*

THE further announcement of the successful continuance of Joliet Works' greatest Accident Prevention Record as indicated in the preceding three issues of "The Mixer" until, as we go to press on the 15th, its excellent and marvelous growth as shown above, provides a feeling of pride and appreciation beyond our sincerest anticipation and the most gratifying time in all our years of endeavor toward Accident Elimination.

In announcing the accomplishing of a record of **two hundred and seventeen days—over 7 month's time for the entire plant without a lost time case,** we can only repeat our statement of many previous occasions —that such a contribution to this wonderful humanitarian cause is very likely the greatest ever attained.

Since the inception of Industrial Accident Prevention which chose Joliet Works as its birthplace, we have been able to show progress at the end of each year over the preceding year, even back in the old days when the efforts to eliminate preventable accidents was not considered as a very important part of plant operations and the efforts to secure co-operation represented a real struggle.

The results which have been accomplished at Joliet Works through all of these years and particularly the past few years well indicates the spirit which prevails and just so long as that spirit and co-operation continues to prevail we will show progress in our campaign, regardless of the fact that our percentage rate and the actual number of lost time accidents is so low that it leaves almost nothing to work on in the line of reduction. Our record for this year thus far where but three (3) lost time cases have occurred will illustrate this point.

We are very happy and proud to repeat our expression of appreciation to every Superintendent, every Foreman, every Safety Committeeman and every Workman on the plant for their assistance in making such a marvelous record and to sincerely solicit their continued help

*The Mixer, November Issue.

Approximately one hundred members of the Chicago District Section of the A. I. & S. E. E., attended the Inspection Trip at the Delta Star Electric Company's plant, Tuesday, November 15, 1927. After a very thorough factory inspection where the various processes of building the unit type line of equipment was shown all of the visitors were conducted to the 750,000 volt testing and research laboratory where demonstrations of standard, special mechanical and electrical tests were made by the engineering department of the Delta Star Company. At six o'clock all of the members of the party were taken to the Hotel Graemere where a very elaborate dinner was served, the Delta Star Company acting as host at the dinner. Mr. E. L. Upp, Chairman of the Chicago District Section, opened the technical session and introduced Mr. R. E. Anderson, who presented a paper covering "Out Door Sub-Station Design." After this paper, Mr. W. H. Boyce presented a paper covering "Spacing of Low Voltage Cables." One of the interesting features of the meeting was a motion picture film showing the construction of a 66,000 volt sub-station. The meeting adjourned with the executives of the Chicago District Section extending to the Delta Star Electric Company their thanks and congratulations on a most successful and educational visit to their plant.

For those applications which are liable to voltage drops of short duration, the Westinghouse Electric and Manufacturing Company has designed a time delay attachment for use on standard low voltage release equipment. This attachment is of particular advantage in paper mills and in other continuous processes where it would be a great inconvenience to have the motors of the plant shut down due to momentary dips in voltage.

The new time delay device is provided with adjustment which allows the low voltage release to open from one-half to two and one-half seconds after the voltage drops below the minimum value. If the voltage remains low longer than the time for which the time delay device is set, the motor circuit will be opened and the equipment protected from excessive currents. This device will keep motors from shutting down due to short harmless surges caused by temporary short circuits and "bumps" due to switching. The usual method of starting and stopping with the auto-started handle is not affected in any way by the addition of the time delay attachment.

The new attachment may be easily applied to any standard, Westinghouse auto-starter, in service as easily as at the factory, since it mounts in the same mounting holes as the standard low voltage mechanism.

The time delay attachment consists of a low voltage magnet which has a dashpot for retarding its opening. After opening slowly a certain distance, a latch releases the magnet so that the starter opens quickly in the usual way. The time adjustment is obtained by varying the position of the fulcrum of the release latch. The dashpot is mounted with the open end down so there is no danger of dirt getting into it.

Centrifugal blowers and compressors as used in blast furnaces, steel plants and by-product coke oven plants are described, together with pumps, turbines and speed reducers, in Bulletin E-1107, distributed by the De Laval Steam Turbine Co., Trenton, N. J. Centrifugal blowers and compressors are built with various numbers of stages, ranging from single stage blowers for blowing air through the fuel beds of water gas generators, to multistage compressors capable of supplying air at 100 lbs. pressure per sq. inch. Centrifugal compressors are extensively used for exhausting gas from by-product coke ovens, and for boosting the pressure of gas for long distance transmission. De Laval centrifugal blowers and compressors are driven by De Laval steam turbines or by electric motors. Speed increasing gears are sometimes used in order to utilize standard speed motors.

It is with regret that we announce the death of Mr. Arthur R. Leavitt, an Electrical Engineer at the Duquesne Works of the Carnegie Steel Company who died December 6 in his home, 542 Celeron Street, Pittsburgh, Pa.

Mr. Leavitt was born in Manchester, N. H., and was graduated from the Electrical Engineering Department of Wooster Polytechnical Institute in 1914.

During the war he served in France for two years in the Aviation Service and upon his return, he became associated with the Carnegie Steel Company.

Mr. Leavitt was an active member of our Society, serving on many of the major national committees. He presented numerous papers and discussions before our meetings, noteworthy among them being his "Report of Standardization Committee on Transmission" and "Single Bucket Blast Furnace Skip Hoist Characteristics."

Mr. Leavitt was known throughout the Electrical Industry, especially in the Iron and Steel Field, as an authority on A. C. Practices and enjoyed the esteem and respect of his superiors and fellow man.

In extending our sympathies to his family and friends, we are mindful that his loss is a great one to the Iron and Steel Industry.

The American Transformer Company begs to announce that George W. Quentin, formerly of the McGraw-Hill Organization, has been appointed Sales Engineer for this Company.

Mr. Quentin has been very active in public utility sales engineering for the past eighteen years, during which time he specialized, not only in sales engineering, but also in industrial engineering. His last connection in the public utility field was with the Duquesne Light Company at Pittsburgh, in the capacity of Power Sales Engineer in charge of sales to the steel mills.

During the war, Mr. Quentin was Electrical and Chief Engineer of the Marlin-Rockwell Company, Inc., who was engaged in the manufacture of the Light Browning machine gun. He is a member of the American Institute of Electrical Engineers, Association of Iron and Steel Engineers, Engineering Society of Western Pennsylvania, Yale Engineering Association, and has been very active in the past in the work of the National Electric Light Association.

The utilization of less metal at less expense to withstand a given load in the construction of industrial buildings is made possible by the development of a new design of roof truss by William Dalton of the General Electric Company's manufacturing department. This truss, instead of being riveted, is fabricated by welding.

Trusses, being the foundation members of a roof structure, must withstand tension and compression strains. Each truss consists of two parallel lengths of metal latticed together by a system of tension and compression members, rivets heretofore being used to fasten the units together. The use of rivets, however, necessitates punching holes in the truss members, and these holes cause a waste of material. This loss, says Mr. Dalton, is equivalent to a strip of metal the full length and thickness of the part in which the hole is punched and as wide as the diameter of the rivet.

The common practice has been to construct trusses with angle iron. In the new truss the two parallel members or cords are made of H beams, the tension members are of channel iron and the compression members, H beams. As an economical fastening is needed and as it is not easy to rivet such a combination of shapes together, welding is used to make the necessary connections. This also avoids the waste of metal caused by rivet holes, and furthermore does not require the use of gusset or connecting plates necessary for riveted joints.

The General Electric Company, by a long series of tests, has proved that a definite size of weld of a given length made with a specified current and electrode has as definite and dependable holding value as a rivet. The General Electric Company contends that skillful arc welders, thoroughly equipped, can make a cheaper connection than the riveted joint of equal strength.

A comparison of riveted and welded trusses designed for the same load and stresses shows that the riveted trusses are about 40% heavier than the welded trusses. Actual quotations received from structural companies show that a considerable saving in cost can be made by the use of the welded truss.

The Johns-Manville Corporation with executive offices at New York have issued a very attractive booklet describing Superex Insulation for Furnaces and other High Temperature Equipment. This booklet describes the Superex Block Insulation and the uses for Superex Block Insulation. This insulation is generally suitable for conditions where the insulation must resist temperatures between 600°

and 1500° F. It is especially adaptable to Heat Treating Furnaces, Re-heating Furnaces, Gas Plant Equipment, Boiler Settings, Coke Ovens and Retorts. The Johns-Manville Corporation will be glad to forward the booklet on request.

The Combustion Engineering Corporation at 200 Madison avenue, New York City is distributing a very interesting pamphlet which contains a story in connection with "Firestone Remodel Furnaces for Pulverized Coal." Increasing steam demands of Firestone Tire & Rubber Co. at Akron, Ohio, were met with same boilers by changing furnaces to burn pulverized coal, prepared by central system. Mr. W. C. Stripe of the Combustion Engineering Corporation will be glad to mail you this story on request.

The Tokio Electric Light Company of Japan recently placed, through the Westinghouse Electric International Company, an order with the Westinghouse Electric and Manufacturing Company for one 25,000 KW. turbine generator. The unit will be built at the South Philadelphia Works of the latter company and installed in the new extension of the Senju Power Plant.

The Senju Power Plant is a steam standby station, located just outside the City of Tokio. This unit will be of the same design as two machines installed there in 1925, and will bring the capacity of the station up to a total of 75,000 KW.

The Tokio Electric Light Company is the largest power company in Japan, and draws most of its power from hydro-electric installations, the standby station and Senju having in the past been idle for as many as eleven months out of the year. In order to make the station serviceable the year 'round, special arrangements will be made so that the generators can be used for Power Factor correction during the season when there is an abundance of water power. This will be the first time that a steam standby station has been so used in Japan.

In order to make the three 25,000 KW generators available as synchronous condensers, special disconnecting couplings will be supplied between the turbines and the generators. These couplings will be arranged to permit connecting or disconnecting the generators while the units are at a standstill. Since the boilers are shut down during the season when the units are not needed for the generation of power, it is necessary to provide means for starting the generators electrically. It was finally determined to do this by means of a motor generator set of sufficient capacity to start one generator at a time electrically. When used in this manner, the 25,000 KW generators will have a capacity of 20,000 kv-a. 0% P.F. leading. In order to facilitate starting of the generator, when used as a synchronous condenser, a special high pressure oiling device will be provided, by means of which lubrication can be established before the generator rotor is rolled over.

The turbine will be of the combined impulse and reaction semi-double flow type, operating at a speed of 1500 rpm. Steam will be supplied to the throttle at 225 lb. gauge pressure, 200° superheat, and pass into the condenser at an exhaust pressure of 1½" mercury.

The generator rating will be 25,000 KW., 100% P.F. and will produce 3 phase, 50 cycle current at a potential of 11,000 volts. Excitation during normal operation will be supplied by direct connected exciters. During the time when the units are being started as synchronous condensers, a common motor generator set will furnish excitation to the unit being started.

The Standard Underground Cable Co., Pittsburgh, Pa., have prepared a pamphlet describing their Standard Junction and Joint Boxes. A very complete description in connection with junction and joint boxes for alternating and direct current service is given. Also, a very complete description in connection with nipples, single and multiple conductor, Type A, B, E, EM, H, M and MU Junction Boxes, Special Junction Boxes, Split Joint Boxes, Joint Protecting Boxes and Joint Box for Armored Portable Cable are also described. The Standard Underground Cable Company will be pleased to mail to the trade a copy of this pamphlet on request.

It is with deep regret that we announce the death of Arthur G. Henricks, Vice President of the Harnischfeger Corporation. Mr. Henricks has been a loyal worker, promoting the industrial growth of the Corporation since 1901. Mr. Henricks had unusual creative ingenuity having a great many patents to his credit. His latest invention was the Arthen Auto Storage System, an electrically operated device for storing automobiles in large garages. The system is used in conjunction with elevators.

Mr. Henricks was born in Milwaukee April 16th, 1879, and died in the same city November 9th, 1927.

Arthur G. Henricks

Mr. Henricks was educated in the District Schools, and completed engineering and business courses in local colleges at Milwaukee.

He advanced step by step in the Corporation through the Mechanical and Electrical Departments, as Erecting Engineer, and Sales Engineer, General Sales Manager, to Vice President and General Manager.

Mr. Henricks commanded the respect of everyone coming in contact with him and was beloved by his business associates and the employees of the Harnischfeger Corporation. He was a member of the A. I. & S. E. E.

James McIntyre Camp, director of the bureau of technical instruction of Carnegie Steel Company, Pittsburgh, Pennsylvania, died at his home in that city October 24th, following a few days' illness from pneumonia.

Mr. Camp was born November 12th, 1859, in the city of Allegheny, now N. S., Pittsburgh, and was graduated as a civil engineer from the University of Western Pennsylvania, now the University of Pittsburgh, and in 1882 became assistant chemist of the Pittsburgh Steel Casting Company. Later he returned to the same school for a two-year course in inorganic chemistry, and in 1889 was made chief chemist of the Allegheny Bessemer Steel Company, which subsequently became the Duquesne Works, of Carnegie Steel Company. In 1907 he was appointed chairman of the Chemists' Committee of the United States Steel Corporation, in which office he directed the work of the Chemists of the various subsidiary Companies of this Corporation in devising, proving, and standardizing the methods of sampling and analyzing iron and steel works materials, which are issued in printed form and made available to the

James McIntyre Camp

public. In 1911 he was transferred to the Pittsburgh offices of Carnegie Steel Company, and has since also directed the various educational activities of this company.

In his career as a chemist, Mr. Camp was an energetic and progressive director and student, and in his laboratory at Duquesne many new and rapid methods of great value to the iron and steel analytical chemists were devised. He was a pioneer in the work of proving and standardizing the methods of sampling and analyzing raw and finished products of iron and steel works, and the methods prepared and published by various committees of chemists of the subsidiary companies of the United States Steel Corporation under his direction are widely used and have been a large factor in eliminating disputes due to discrepancies in the results of analysis. The accurate analysis of materials used in the steel works is of prime importance in the operation of the plants. Hence, this work, though of intangible value, was of great importance commercially.

With Francis C. Phillips and others, he formed the chemical section of the Engineers' Society of Western Pennsylvania, which later became the Pittsburgh Section of the American Chemical Society. At the time of his death he was also a member of the Iron and Steel Institute (British), the American Iron and Steel Institute, and the American Society for Steel Treating. At intervals from 1882 to 1921, he presented valuable papers before some of these societies. With C. B. Francis, he was also co-author of the Making, Shaping and Treating of Steel, which is not only widely used as a text book in technical schools, colleges and universities of this country and Canada, but is also recognized as an authoritative work of those engaged in the field of steel manufacture.

Catalog Number 27 of the Bull Dog Electric Products Company, Detroit, Michigan, is a handsomely illustrated book describing Safety Switches. Write the Bull Dog Electric Products Company for your copy.

The George J. Hagan Company have received a contract from the F. I. A. T. Company of Torino, Italy, for a number of electric furnaces for the heat treatment of automobile parts. The contract covers one four-chamber counterflow pusher type carburizing furnace, three rotary hearth furnaces and one four-chamber car type furnace. The equipment will have a total connected load of 1500 kilowatts. The transaction was handled by Mr. A. D. Dauch of the George J. Hagan Company, through Deutsch-Amerikanische Elektroofen of Berlin, Germany.

Automatic welding equipment for making metal railroad ties from scrap rails is announced by the General Electric Company. By means of this equipment railroads can make their own metal ties, or manufacturers can build them for sale. The placing of this new machine on the market follows the discovery by William Dalton announced earlier this year, that this type of tie is practicable.

The metal railroad tie has advantages over the wooden tie in the way of longer life and greater strength. It is of simple construction and can be made in an automatic welding machine at low cost.

The new welding apparatus developed for this work consists of an automatic tie-welding machine and a 1500-ampere motor-generator set with two circuits for hand welding and two circuits for automatic welding. The following equipment is involved:

1. A section of a roller conveyor on which the rails are moved into position for welding.

2. A jig for correctly spacing the rails and locating the tie plates on top of the rails.

3. Two pneumatic plungers for rigidly holding these parts in position.

4. A pair of spring and toggle operated clamps for holding the angle irons against the ends of the rails.

5. A mechanism which rotates the whole jig with its rails and plates. This turns in either direction a distance of 45 degrees from the perpendicular, permitting automatic welding to be done first on one side of the tie plate and then on the other.

6. Two automatic welders mounted on individual travel carriages for welding the two tie plates simultaneously.

7. A track on which the travel carriages ride.

8. A supporting framework.

Each metal tie consists of two lengths of worn or scrap rail cut to length and held together at both ends by angle bars which are welded to the rails. The rails are further held together by two tie plates which are welded to the top or head of the rails at the point where the track work is clamped to the tie. The tracks are clamped to the tie plates by means of rail clamps and spring steel keys.

The actual operation is as follows:

The rails are inserted into the machine and the tie plates placed in position. The equipment is then fixed in position by means of compressed air. The angles are next placed in position, after which the work is rotated to a point where the joints between the plates and one rail may be welded. The first welds are then made automatically, the arcs moving away from each other. The fixture is then rotated to a point where the other joints are beneath the electrode and the welds are made with electrodes moving toward each other.

While the automatic welds are being made the operator welds the angles to the ends of the rails by hand welding. All welding being completed, the fixture is turned back to normal position and the completed tie removed.

For maximum production the machine requires two operators, one for each of the two automatic heads. Each head has a separate control panel, thus making each operator largely independent of the other. Estimated output of the machine with two operators is one tie every five minutes.

READING MEETING

(Continued from page III)

this month's issue of the Iron and Steel Engineer. The discussion of this paper will appear in the February issue of the Iron and Steel Engineer. The Philadelphia Section, headed by Mr. G. B. Walz, Asst. Elec. Supt., Bethlehem Steel Company, Steelton, Penna., is to be congratulated upon the successful meetings that are held at Reading each year.

Mr. F. H. Willcox, Vice President of Freyn Engineering Company has just returned from a three months' absence in Europe. During this period he visited Belgium, France, Germany, Luxembourg and England. The trip was taken in connection with three contracts which the Freyn Engineering Company is now executing, inclusive of the remodeling of Dudelange Blast Furnace plant at the Acieries Reunies de Burbach Eich Dudelange, Luxembourg and the reconstruction of two furnaces at the Mannesmann Tube Works, Huckingen, on the lower Rhine. During his visit in Europe Mr. Willcox also made a study of methods there extant for the conditioning of blast furnace gas and the use of blast furnace gas alone or in mixtures for coke oven, open hearth and heating furnace applications.

The properties of Standard Underground Cable Company have been acquired and its current obligations assumed by General Cable Corporation (formerly Safety Cable Company) which has also acquired the properties and assumed the current obligations of Rome Wire Company, Dudlo Manufacturing Corporation, Baltimore Sheet and Wire Company, and Phillips Wire Company.

There will, however, be no change in the personnel of the management, which will continue the business of Standard Underground Cable Company as a Division of General Cable Corporation.

The consolidation is expected to be of advantage to each of the business consolidated and of substantial benefit to the entire industry, and those served by it.

Centrifugal Pumps and their types, designs and uses, form the subject of a copiously illustrated book distributed by the De Laval Steam Turbine Company, Trenton, N. J. The centrifugal pump, in the past 25 years, has reached a high degree of refinement. Separate chapters of the present work take up the requirements of pumps for general water service, power plant service, water works service, sewage and irrigation pumping, supplying high pressure water to elevators and hydraulic machinery, marine service, mine pumping, fire protection service, hot water heating and brine circulation service, handling oils and paper pulp, etc. The final chapter treats of pump characteristic curves and gives formulae and constants useful to the pump user.

A record has been made for consecutive orders for large capacity electric cranes by The Morgan Engineering Company in October and November to date that is without parallel in the history of this company.

Starting with orders for a few small cranes in October, our first large order consisted of one 175-ton ladle crane, three 50-ton standard cranes, and one soaking pit crane for The American Rolling Mill Company, Middletown plant.

This was followed with an order for a 200-ton locomotive handling crane for the Canadian National Railways, the crane to be installed in their Stratford, Ont., shop.

The next order was for a 250-ton, special three girder crane for The Bethlehem Steel Corporation for installation at their Lackawanna plant.

This was followed by an order for two 75-ton cranes, span 120'0" for The McClintic Marshall Construction Company, one crane to be installed at Pottstown, Pa., the other at Rankin, Pa.

The Continental Steel Company of Kokomo, Ind., were next with an order for a 125-ton ladle crane, one soaking pit crane, and one low type open hearth floor charging machine, all for installation at Kokomo.

This order was followed by an order for a 150-ton and a 100-ton ladle crane. (We are not at liberty to divulge the name of the purchaser).

Next came an order for a 100-ton ladle crane for The Youngstown Sheet and Tube Company, followed by a 75-ton crane for the same company.

To sum up the orders referred to, there are a total of sixteen (16) classified as follows:

1—200-ton special locomotive handling crane.
1—250-ton special 3-girder crane.
1—175-ton ladle crane.
1—150-ton ladle crane.
1—125-ton ladle crane.
2—100-ton ladle cranes.
3—75-ton standard cranes.

3—50-ton standard cranes.
2—Soaking pit cranes.
1—Low type open hearth floor charging machine.

The total estimated weight of the above sixteen machines is 5,576,000 pounds, or an average weight of 348,500 pounds each, or 174½ tons each.

Deducting the three special machines, we find the combined rated lifting tonnage capacity (including auxiliary hoists) of the thirteen regular cranes to be 1,785 tons, or an average of 137.3 tons per crane.

It is significant that the orders for the sixteen machines mentioned are consecutive and this record is without precedent in the history of The Morgan Engineering Company.

The "Ball" was started rolling by The American Rolling Mill Company on October 7, and the contract for the 75-ton crane for the Youngstown Sheet and Tube Company was placed on November 25.

A new type of steel bridge that is practically a one-piece structure was completed in Turtle Creek, Pa., recently and is attracting widespread interest among railway structural engineers as the first completed all-welded railroad bridge in the world. The bridge consists of smooth continuous beams, joined together by the electric arc welding process which eliminates rivets and bolts. It spans the historic creek on the Turtle Creek-Linhart branch of the Westinghouse Electric and Manufacturing Company's interworks railroad.

The bridge, 62 feet long, contains only 20 tons of steel. This represents a notable saving in steel and weight over a rivetted bridge of similar size whose weight would have been between 25 and 30 tons.

The initial test of the structure was made when a 185,000-pound locomotive steamed across the new one-piece bridge.

Preliminary to the actual raising of the bridge the huge girders were welded in the shops and made all ready to lay. The old bridge was then lifted from its foundations, the new girders placed, all members welded and the tracks laid. These operations were accomplished in one day and a half. Four arc welders did the work.

In addition to its service on the interworks railroad this span forms an important shipping connection for railroads operating through East Pittsburgh. The one-piece bridge will be subjected to the most exacting tonnage tests as it was designed to carry the largest generators built at East Pittsburgh. Because of the great weight of these machines it is necessary to ship them on cars built especially for this purpose.

The bridge was designed and built by the Westinghouse Works Engineering and Maintenance Department.

Thomas A. Edison, electrical wizard of West Orange, N. J., recently saw and heard himself talk for the first time, when the initial showing was made of talking movies taken during his radio broadcast interview on Edison Night, October 21, 1927. The film was shown in Edison's laboratory by special equipment installed by the General Electric Company before a small audience consisting of Mr. Edison's family and a few personal friends.

The making of this film was accomplished in an unusual manner. Picture and voice were recorded by two sets of apparatus nearly 200 miles apart, yet both records were perfectly synchronized later on one film. This is believed to be the first time such a feat has been done.

On the evening of October 21, C. F. Bateholts of the General Electric Company recorded motion pictures of the interview given by Mr. Edison to E. W. Rice, Jr., in the West Orange laboratory. The camera was operated by a small synchronous motor. While Mr. Bateholts was making this picture, assistants in the general engineering laboratory of the General Electric Company at Schenectady were recording the speech, carried over the 200 miles' stretch in electrical impulses over a telephone wire. The sound recorder at Schenectady was also driven by a synchronous electric motor.

The motors on both the camera and recorder were rated at one quarter horsepower with a speed of approximately 1,100 revolutions per minute. The remarkable accomplishment in this case was that both motors were operated at the same speed, remaining in the exact synchronism, so that at the end of the run both had made precisely the same total number of revolutions. If this had not been done a discrepancy between pictures and voice would have made this talking movie impossible. The fact that the motors were exact duplicates would not insure perfect synchronism in this case as one motor was being operated by electric power supplied by the New York Power and Light Corporation in Schenectady and the other by electric power from the lines of the Public Service Electric and Gas Company of New Jersey. A slight variation in the frequency of current on either line would have changed the speed of the motors, perhaps only one quarter revolution in a thousand, but enough to have upset the plans.

The Public Service Company, in co-operation with the New Jersey Bell Telephone Company, extended their line through a neighboring company at Millbirn, N. J., to the New York power system at Schenectady. This tie-in made possible the operation of both motors at identical speed and the result was that the same film speed was maintained through both cameras. The two negative films, after being developed, were then printed upon a single positive film, which was used in presenting the unique show to Mr. Edison.

The film is of standard size. Along the left margin, about one-eighth of an inch wide, the voice is recorded in a small saw-toothed line. As a beam of light passes through this line, the broken ray falls upon a photo-electric cell, which changes the light to electrical or radio impulses, easily changed into sound again by a radio receiver and loud speaker. The projector used in showing the talking movie is of the standard theater type with a device added for producing the sound.

Bulletin G-5, Crouse Hinds Co., describes Groundulets and other Safety Circuit Devices. Write Crouse Hinds Co., Syracuse, N. Y., for copy.

"When Industry Says Stop" is the interesting title of a new booklet on Magnet Brakes, issued by The Cutler-Hammer Mfg. Company.

The book explains in detail the construction and operation of all types of Magnet Brakes—both for alternating and direct current. In addition it contains tables showing the exact size and type of Brake for use with the various types of mill and crane motors.

A great deal of care evidently went into the writing of this book and it is worthy of a place in every reader's files. It will be sent free upon request to The Cutler-Hammer Mfg. Co., at 199 Twelfth Street, Milwaukee, Wisconsin.

Fog, one of the greatest hazards to aviation, may lose some of its dangers in the near future as the result of the development of a new type of quartz neon gas-filled lamp by research engineers of the General Electric Company. This lamp, which resembles a ball of reddish orange fire when in use, emits practically all its visible radiation in the long wave lengths, which tests have shown to have greater fog penetrating power than light higher in the spectrum.

It was found that during a heavy morning mist, when the laboratory building in which the new lamp was housed could not be seen 500 feet away, the brilliant red glow penetrated to a distance of half a mile or more. In discussing the possibilities of neon light for aviation purposes, C. G. Found, who developed the new lamp said:

"We don't know yet how far this red light can be seen. However, a neon lamp of earlier type with but half the candlepower, was reported seen by an aviator on a clear night at a distance of 75 miles. We are going to place this new light and one of the standard white light airport beacons on the roof of one of our tall factory buildings in Schenectady. In this way we hope to learn from direct visual tests just how much of an advantage the neon light has in bad weather. We think that, because of the contrast in color, the red light will be helpful to aviators in more easily picking up guiding beacons and landing fields at a distance."

Quartz is used in the lamp because of the heat generated in its operation. The temperature is about 1200 degrees Fahrenheit, which is above the fusion point of glass. Quartz, however, will stand temperatures up to 2000 degrees F. before beginning to soften.

Another feature of the new lamp is its operation on low voltage, substantially that used in household service. Previous types of neon lamps required very high voltages, often as much as 15,000 volts, to enable them to produce sufficient candlepower to make them useful. Such voltages are not only dangerous unless carefully guarded, but they require special equipment to produce them.

According to Mr. Found, the use of low voltage is made possible by a hot cathode within the tube, which provides sufficient electron emission to supply the current for the luminous discharge, and also results in increased length of life of the lamp. "We have found in tests," he said, "that there is less tendency for the neon gas to disappear and blacken the lamp when low voltages are used. One of these hot cathode lamps has now operated for 3,000 hours and has showed no signs of deterioration."

The beacon lamp consists of a small quartz tube wound in a close spiral 1½ inches in diameter. This is done for the pose of obtaining as nearly as possible a concentrated spot of high brilliancy which can be placed at the focal point of the usual type of searchlight reflector. By this means a narrow concentrated beam of colored light can be made to reach much further than the light from a larger tube.

A new type of unbreakable attachment plug made of rubber is announced by The Cutler-Hammer Manufacturing Company, 611 Twelfth street, Milwaukee, Wisconsin.

This rubber plug is not only unbreakable but will not mar floor or furniture. It should be of interest to factories, repair shops and other users of small motor driven tools as well as users of other electrical appliances because impact on cement or wood floors will not harm the plug or the floor.

The plug is made of a high grade of rubber and is very light in weight. The terminals are fastened in a Bakelite strip firmly embedded in the rubber base. Rivet and anchor construction hold the terminals to the Bakelite and keeps them from turning. Staked screws prevent loss and save time in wiring.

When the plug is used with rubber cord it is exceptionally easy to apply a strain relief to relieve the strain between cord and plug. A small dab of ordinary rubber cement placed between the two, holds them firmly and permanently together.

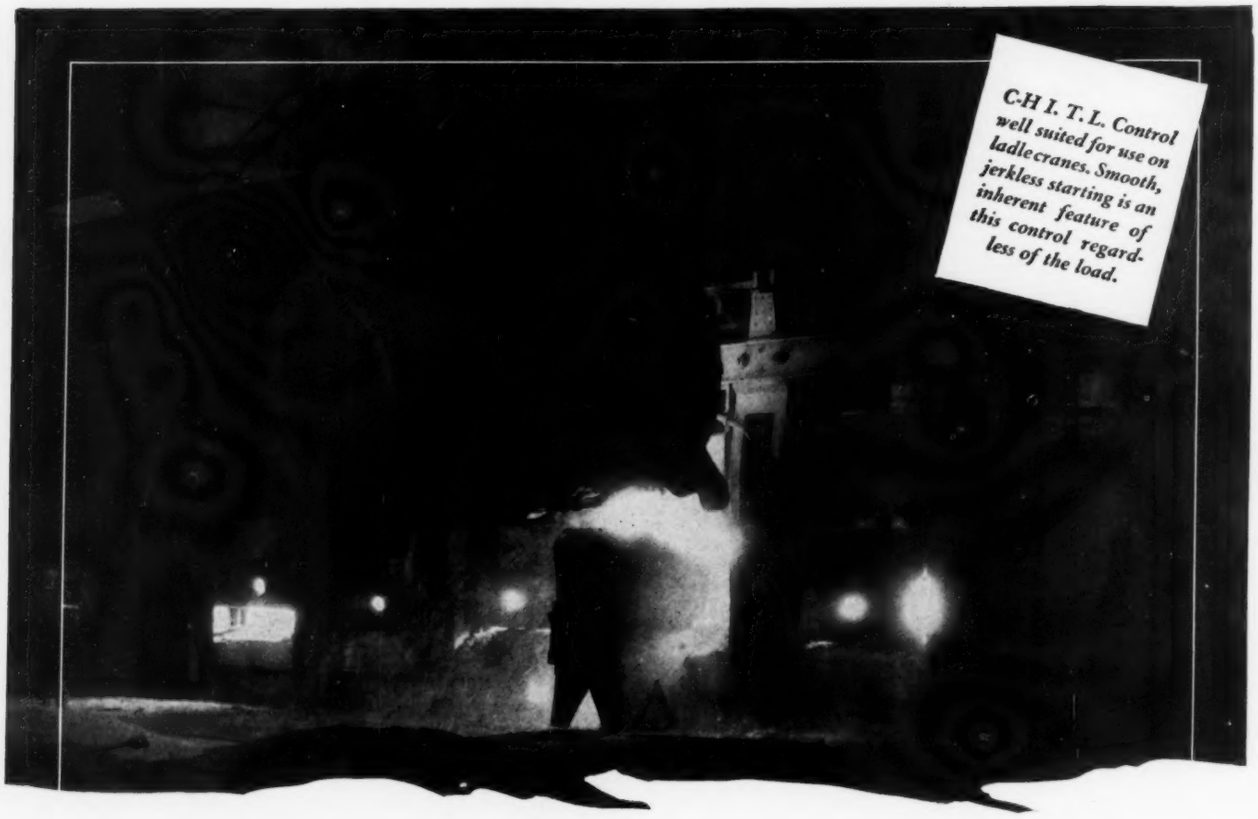
It will be remembered that Cutler-Hammer was the first to develop the unbreakable type of attachment plug. Their famous "Dreadnaught" cap is still widely used today. It is expected that this new unbreakable rubber cap will meet even greater favor than the steel Dreadnaught.

Mr. L. E. L. Thomas has recently become identified with Freyn Engineering Company in the capacity of Vice President, in charge of foreign business.

Mr. Thomas has been active in the steel industry for many years. After a varied construction experience in the iron and steel industry, he was made Chief Draftsman of The Youngstown Sheet & Tube Company, Youngstown, Ohio.

In 1916 he became Chief Engineer of Gary Tube Company in connection with a plant to include docks, blast furnaces, steel making capacity, rolling mills and tube mills. With the suspension of that work, on account of war-time conditions, he was appointed Chief Engineer of United States Steel Corporation, Ordnance Department, which commenced the construction of a plant, for the United States Government, for the production of large guns and projectiles. On the abandonment of that project, as a result of the War's close, he resumed his former position with Gary Tube Company.

In 1920 he became Chief Engineer of Inland Steel Company, Indiana Harbor Works, holding that position until his resignation in 1927.


C-H I. T. L. Control well suited for use on ladle cranes. Smooth, jerkless starting is an inherent feature of this control regardless of the load.

One mistake ruins an armature

Armatures do not burn out of themselves. It is only when the operator asks a motor to do the impossible—then armatures fail.

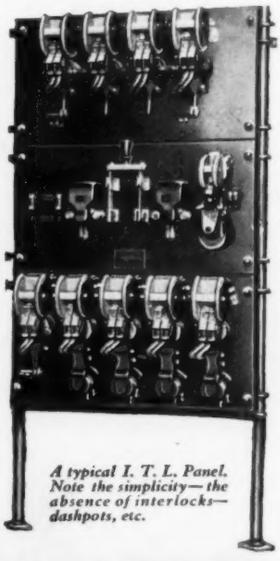
Steel mills demand Motor Control that will not permit the operators to mishandle motors. Steel mills need Control that cannot fail in its primary duty of protecting motors.

Your mill can keep armatures out of the repair shop *and in the motors* by installing Cutler-Hammer *Inductive Time Limit Control.* This control makes a motor accelerate its load—or get off the line. It provides easy starting for the average load yet gives plenty of power for the heavy job.

This efficient control is simple, too. It has no dashpots, relays and no interlocks on the accelerating contactors.

If you haven't had the complete story on this better control you owe it to your mill to investigate. Ask for the I. T. L. Booklet.

Redesigned switch construction increases life of contactors approximately two to ten times depending upon type. Arc shields on all types are almost indestructible. Write for details on these remarkable improvements.

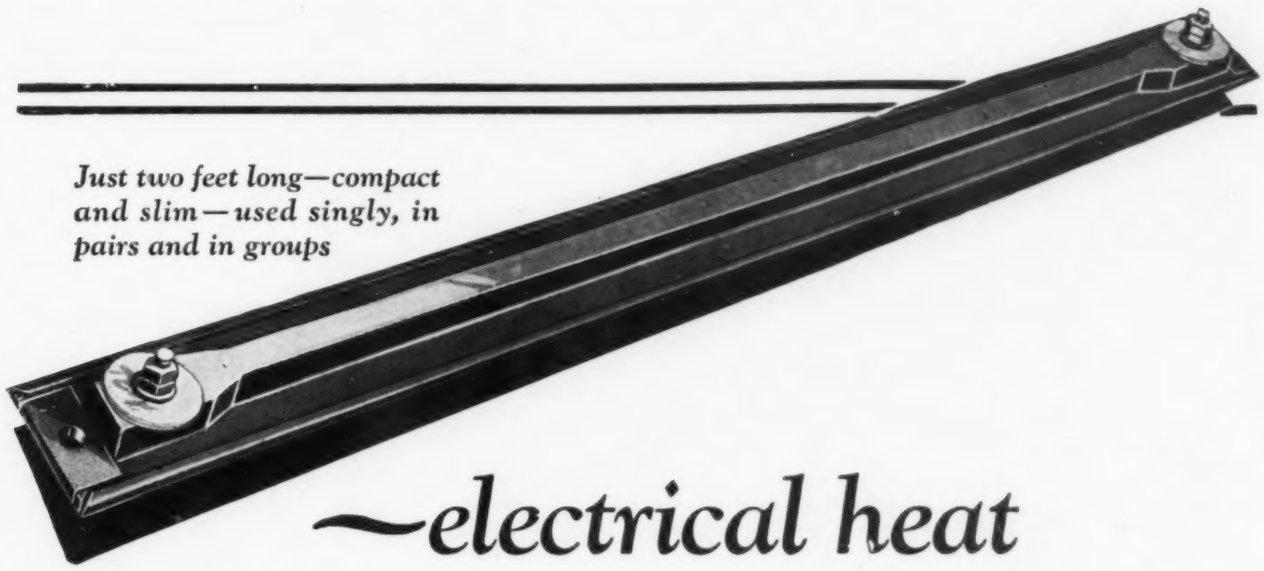


A typical I. T. L. Panel. Note the simplicity—the absence of interlocks—dashpots, etc.

The CUTLER-HAMMER Mfg. Co.
Pioneer Manufacturers of Electric Control Apparatus
1244 St. Paul Avenue
MILWAUKEE, WISCONSIN

CUTLER C-H HAMMER

Industrial Efficiency Depends on Electrical Control



Just two feet long—compact and slim—used singly, in pairs and in groups

—electrical heat in its most adaptable form

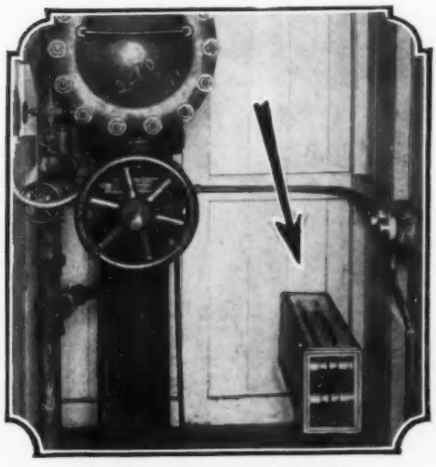
WHEREVER electricity is available, Cutler-Hammer Space Heaters can be used. Small, handy in shape, they are most economical of space. Can't upset —they are safe.

Ideal for crane cabs, watchmen's houses or other isolated buildings, drying rooms, vaults, ovens, and for applying heat at specific points in manufacturing processes.

Whenever clean, safe heat is necessary, electrical heat is best, and these C-H "Heat Sticks" are handiest. Easily installed—singly, in pairs or groups. Give the right amount of heat at any point you want it.

With such adaptability, no wonder C-H Space Heaters are solving more heating problems every day. They will do the same for you.

The Cutler-Hammer Space Heater has the heating coil completely embedded in an improved refractory material which assures quick, efficient heating.



C-H Space Heaters protecting fire extinguisher valve from freezing—plant of Wilson Co., Chicago.

Order them from your electrical supply house by the box or singly. $2.00 each—less by the box.

The CUTLER-HAMMER Mfg. Co.
Pioneer Manufacturers of Electric Apparatus
1244 St. Paul Avenue
MILWAUKEE, WISCONSIN

The "Dictionary of Uses" describes scores of typical ways C-H Space Heaters may prove valuable to you. Write for a copy.

CUTLER C-H HAMMER

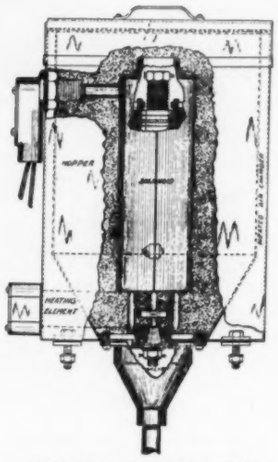
Pioneer Manufacturers of Electrical Apparatus

It Takes SAND To Win!!

The Human Sander

Almost any healthy crane operator has it—aplenty. But why use it for sanding runways? You can put it to much better purpose—a dozen times a day. Far better to keep him in his cab out of danger—let him use the automatic sander pictured at the right. With a slight pressure of foot or hand he can release sand when, as and if needed, without regard for wind or weather.

The heated element keeps the sand in condition for prompt flow, the sand goes directly to the rail, and the crane continues its work without a second's break. It minimizes danger, speeds up production and reduces the chances of misalignment. It is the answer to the human sander evil.

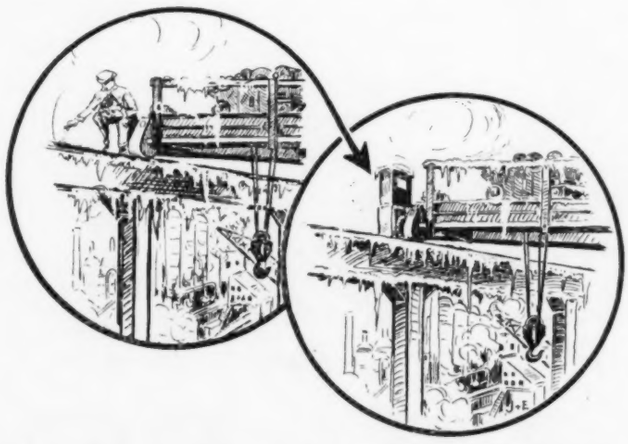


The Electro-Magnetic Sander

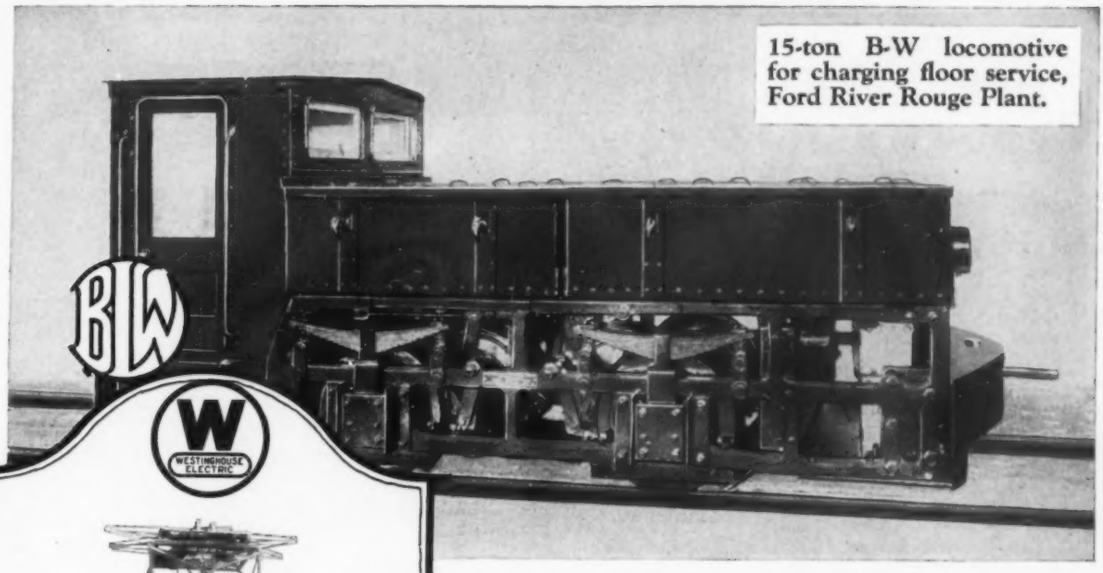
THE NICHOLS-LINTERN CO.

7960 LORAIN AVENUE CLEVELAND, OHIO

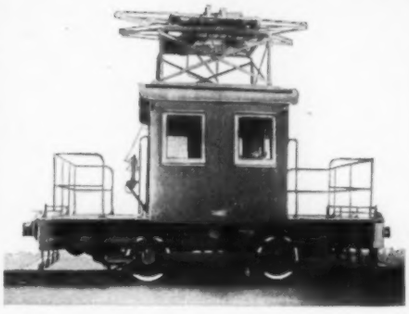
Now Choose!



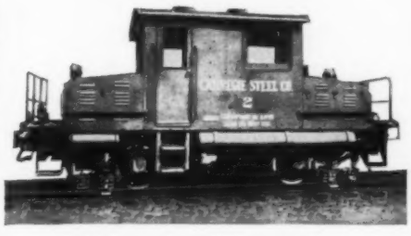
How will you sand the outside runway in your plant this winter?



15-ton B-W locomotive for charging floor service, Ford River Rouge Plant.



25-ton combination B-W locomotive for Ford Motor Company.



35-ton remote control B-W locomotive for by-product coke service.

80-ton B-W locomotive for yard service and switching.

Speed Production and Cut Costs!

FROM ore dock to finished steel, Baldwin-Westinghouse Electric Locomotives are speeding production and cutting costs for the largest steel manufacturers in America.

They eliminate standby losses and utilize electricity already available by trolley, third rail, or a combination of either and storage battery, or for isolated installations, full storage battery.

And they are built in sizes and types for every hauling service from the small low-height mine locomotive to the large 80-ton locomotive for yard switching.

Write for Special Publication 1774.

Address either company

The Baldwin Locomotive Works
Philadelphia Pennsylvania

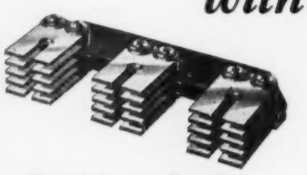
Westinghouse Electric & Mfg. Co.
East Pittsburgh Pennsylvania

Baldwin–Westinghouse

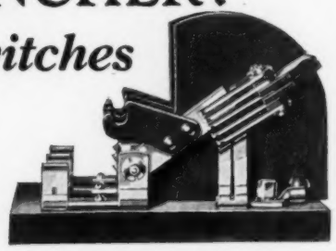
X92793

A REAL ARC QUENCHER!

with WK-55 Full Safety Switches



Three Pole Arc Quencher



Switch Blades Passing Through Arc Quencher

W WESTINGHOUSE ELECTRIC

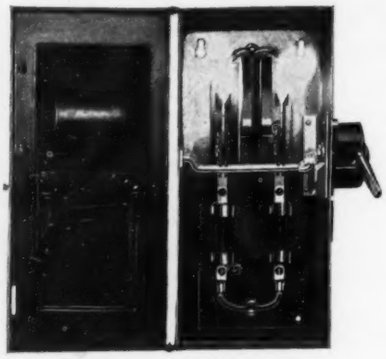
1st Stood the test for five years.

2nd Good for D-C. and A-C.

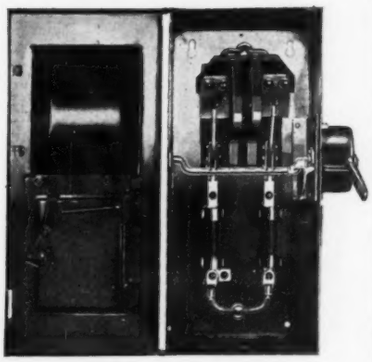
3rd Does not deteriorate.

4th Made of Micarta and Steel plates—not affected by moisture.

5th No moving parts.



K-55113, 60 Ampere Switch Opening 150% Load without Arc Quencher

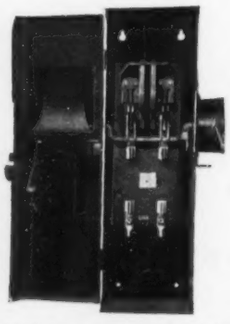


K-55113, 60 Ampere Switch Opening 150% Load with Arc Quencher

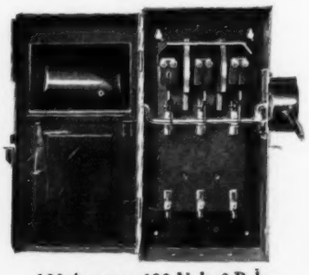
IN any emergency in your plant—it's up to someone to throw the disconnecting switch with a heavy overload on the line. . . . Your men are fully protected by the type WK-55 from that dangerous flash and possibility of being burned when the disconnect switch is pulled. . . . The Arc Quencher—eliminating the flash—and the interlocking door—that prevents tampering—gives double protection.

. . . . IT'S NOT NECESSARY TO USE OVERRATED NO-FUSE WK-55 WESTINGHOUSE FULL SAFETY SWITCHES IN ANTICIPATION OF A STALLED ROTOR, FIRE OR OTHER EMERGENCIES. . . . WK-55's are supplied in 30 to 1200 ampere and 250 to 600 volt sizes.

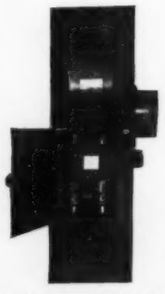
Let your Westinghouse representative explain this type of Heavy Duty Safety Switch or write today for Catalog 41-A.



200 Ampere, 250 Volt, 2 Pole Steel Mill Type Main Door Open



100-Ampere, 600 Volt, 3 Pole Showing Main Door Open for Inspection of Switch

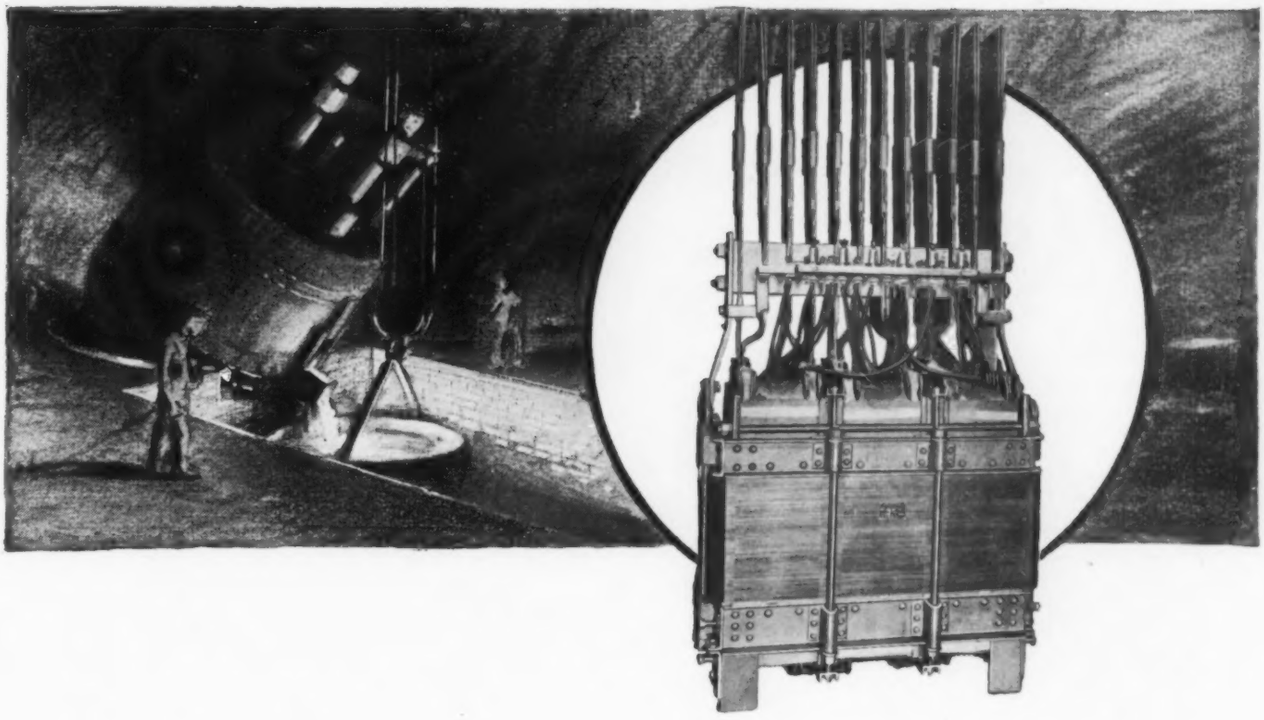


200 Ampere, 250 Volt, 2 Pole Steel Mill Type-Fuse Door Open Switch in OFF Position

Westinghouse Electric & Manufacturing Company
Merchandising Department
Mansfield Works Mansfield, Ohio

Westinghouse

X95529



Shell Type Construction

for

Greater Strength

THE shell type of construction braces the coils against the shock caused by sudden rushes of current. It is especially adapted to transformers supplying power for electric furnaces because of the severe nature of this service.

In the shell type of construction the iron laminations are built around the coils, clamping them together. The iron completely encases the coils except at the ends which are otherwise braced.

This is one of the reasons why Westinghouse transformers are giving such good service with electric furnaces. Let us tell you the others. There is a Westinghouse district office near you.

Westinghouse Electric & Manufacturing Company
Sharon Works Sharon, Pa.
Sales Offices in All Principal Cities of the United States and Foreign Countries

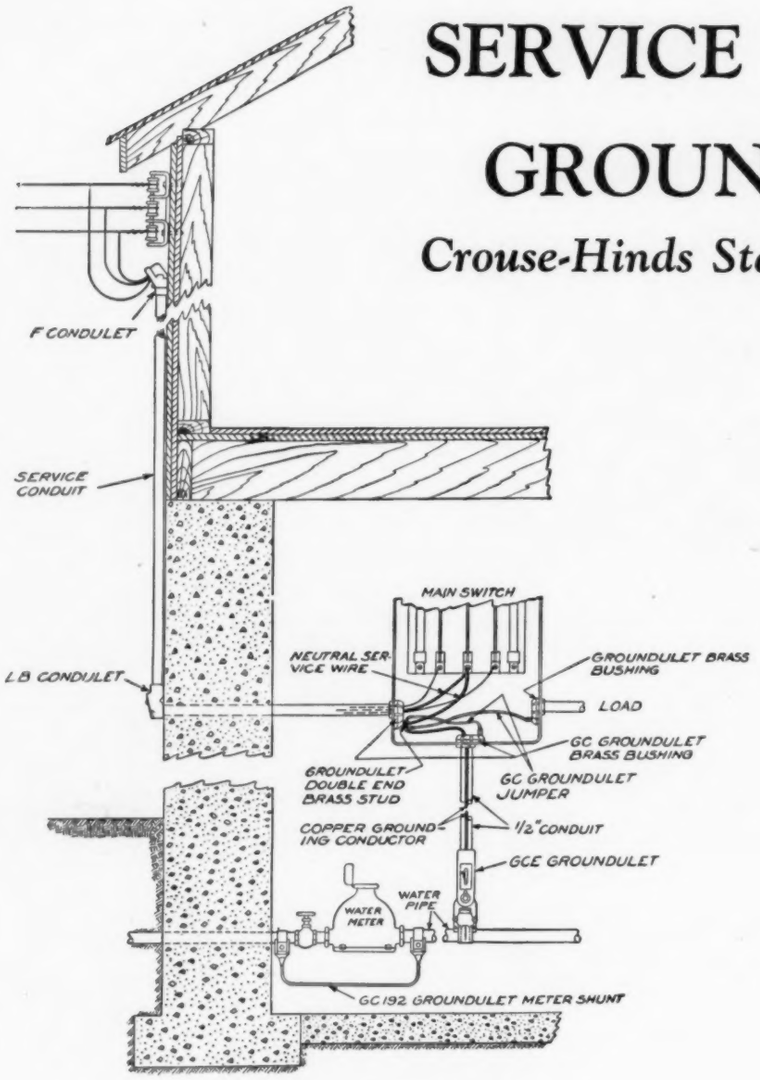
Transformers *for* Electric Furnace Service

Westinghouse

X95088

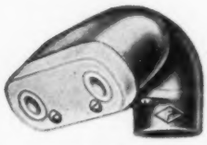
SERVICE ENTRANCE
and
GROUND SYSTEM

Crouse-Hinds Standard Safety Circuit



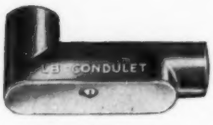
RESIDENCE INSTALLATION

Type F—Form 6
With Three-Wire Porcelain Cover
(½ to 1 Inch)



Type F—Form 7
With Two-Wire Porcelain Cover
(1¼ to 6 Inches)

Type LB—Form 6
With Blank Metal Cover
(½ to 1 Inch)



Type LB—Form 7
With Blank Metal Cover
(½ to 6 Inches)

Type GCE Groundulet

Groundulet Double End
Brass Stud

Groundulet Brass Bushing

Groundulet Jumper

Groundulet Meter Shunt

Groundulet equipment is listed in Bulletin G–2; Types B and F Condulets are listed in Bulletin 2100

CROUSE-HINDS COMPANY

ESTABLISHED 1897

SYRACUSE, N. Y., U. S. A.

SALES OFFICES

NEW YORK
PHILADELPHIA DETROIT CLEVELAND
PITTSBURGH CINCINNATI ATLANTA

BOSTON

CHICAGO
ST. LOUIS MINNEAPOLIS
SAN FRANCISCO MILWAUKEE

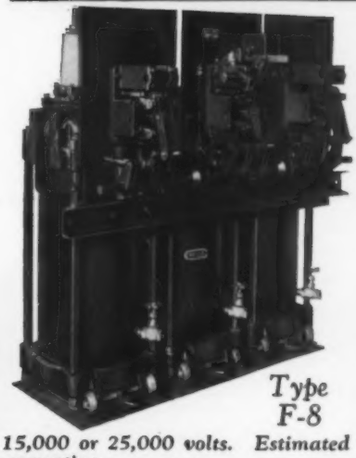
CH 324

TOWERS of STRENGTH

Like the impregnable strongholds of the feudal barons, Condit Types F-8, F-19 and F-9 Oil Circuit Breakers are veritable towers of strength.

All steel construction, four breaks and high speed of circuit interruption — they spell security for high power circuits up to 750,000 Kv-a.

CONDIT ELECTRICAL MFG. CORP.
Manufacturers of Electrical Protective Devices
BOSTON, MASS.
Northern Electric Company
LIMITED
Distributor for the Dominion of Canada



Type F-8

SPECIFICATIONS:—*Types F-8, F-19 and F-9: Standard capacities 15,000 or 25,000 volts. Estimated interrupting capacity 18,000 to 30,000 amperes at 15,000 volts. For truck type or platen mounting.*

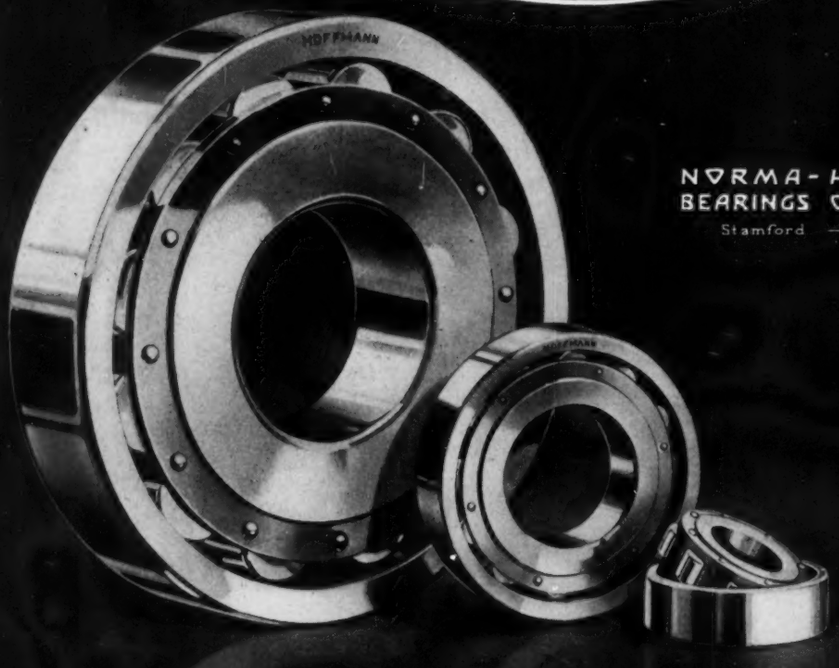
CONDIT

1230

"HOFFMANN"
PRECISION
ROLLER BEARINGS

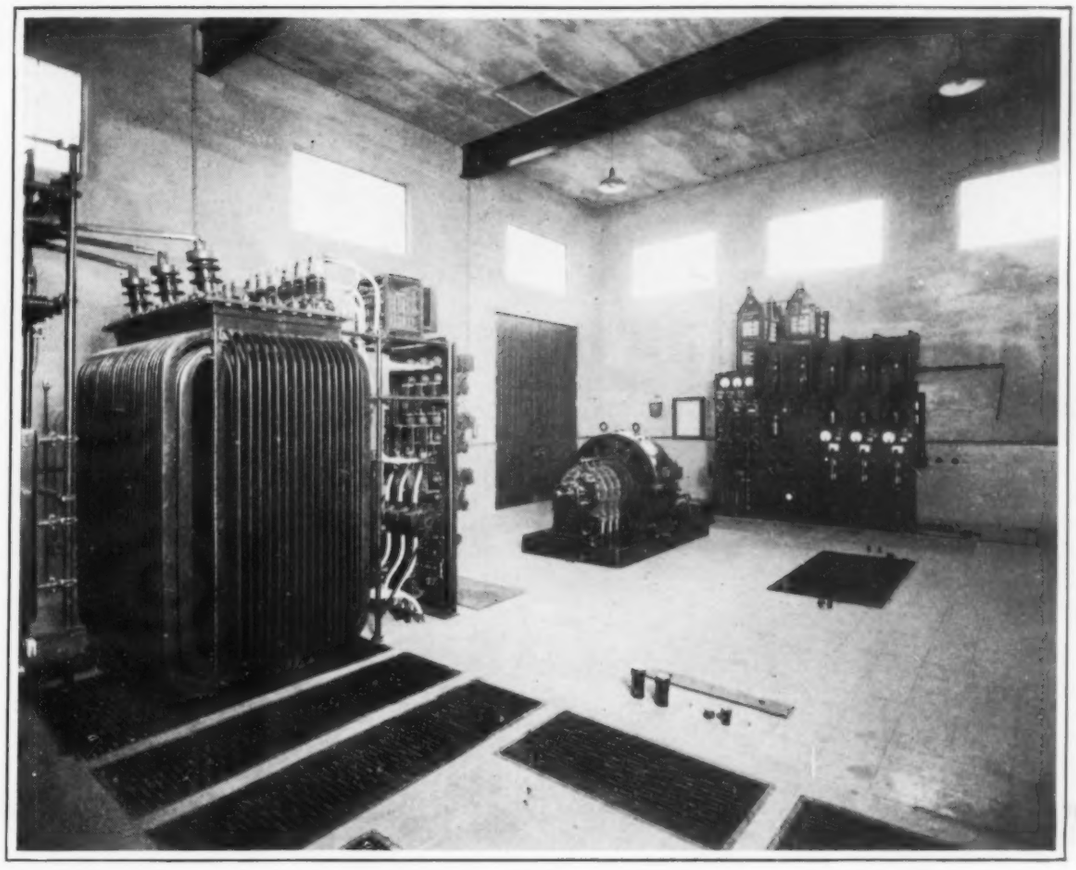
There is probably no service so severe that the right **"Hoffmann"** Bearing will not meet it, successfully and economically. Its most noteworthy achievements have been those in which it has stood up under loads which brought failure to every other bearing tried. If dependability is the thing you seek above all else, in bearings, the **"Hoffmann"** is ready to qualify. Ask our engineers.

Have you Catalog 904?



NORMA-HOFFMANN
BEARINGS CORPORATION
Stamford — Connecticut

N-35



In the first full automatic railway substation in San Francisco

EVIDENCE of the ability of correctly chosen National Pyramid Brushes to stand not only normal loads, but prolonged overloads, is to be had in San Francisco. There the Market Street Railway Company has on San Bruno Avenue the first full automatic railway substation to be erected in that city. It is equipped with a 750 Kw., 600-volt, 1250 r.p.m. rotary converter. This machine operates at 75 per cent of its rated capacity, except during the rush hours. Between 7.30 and 9 in the morning and 4 and 6 in the afternoon the converter carries 100 per cent overload.

National Pyramid Grade 259 was supplied as original equipment on the DC side of this machine, and is carrying not only the normal loads but also the overloads with practically sparkless commutation.

National Pyramid Grade ET-10, on the AC side, was also part of the original equipment.

Our Sales Engineers are at the service of both manufacturers and users of electrical equipment. In many cases they have been able to end vexing brush troubles; and in others to add to the capacity and utility of equipment. Write, wire or phone and the experience of these men will be put at your disposal.

NATIONAL CARBON COMPANY, INC.

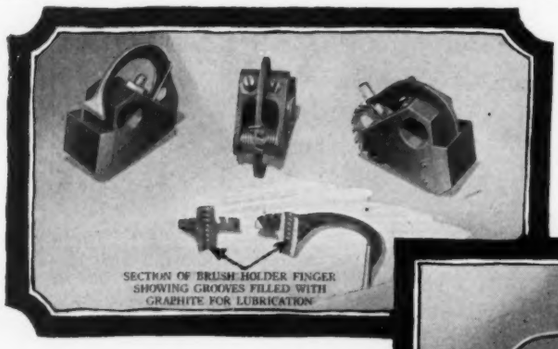
Unit of Union Carbide and Carbon Corporation

Cleveland — SILVER STRAND CABLE TRADE MARK REGISTERED — San Francisco

Emergency Service Plants are located in

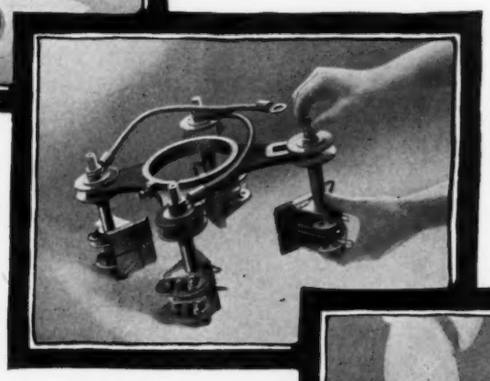
CHICAGO PITTSBURGH NEW YORK, N. Y. BIRMINGHAM

The "Inside" story of Type T Reliance Motors No. 8



Reliance Reaction-type Brush Holders

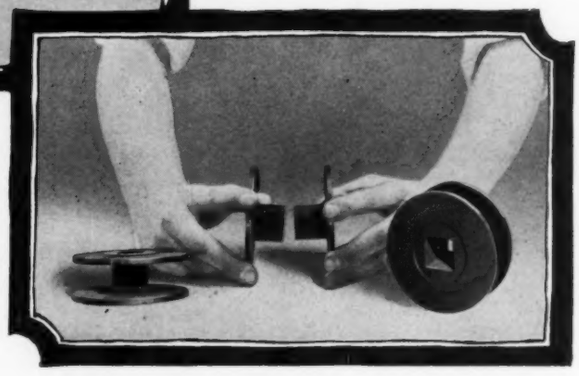
Spring action on the brush holder arm is from the middle of the holder, thus assuring even distribution of pressure on the brush.



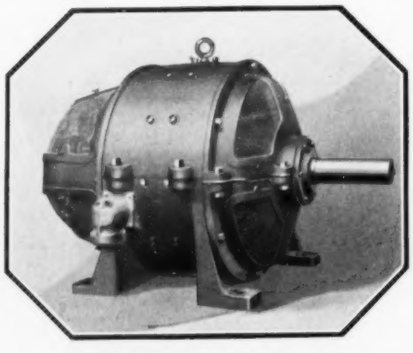
Brush Yoke with Brush Studs, Insulation and Brush Holders. The holders, studs, washers and nuts are all of brass.

Moulded Composition Brush Stud Insulation

The squared tubular portion is moulded integral with the end washer. The two parts telescope, giving a large creepage distance to ground. The telescoping sections are moulded to close limits and fit snugly.



Good brush rigging, well insulated



Six-pole Type T Reliance Motor with roller bearings.

No man responsible for motor maintenance needs to be reminded of the importance of good brush rigging and insulation. There are no parts of Type T motors that have received more thorough attention.

Reliance reaction-type brush holders have an eleven-year record for smooth operation and good commutation. With improved design and construction these holders combine the advantages of the reaction-type with those of the box-type.

A brush yoke is used so that brush studs may be easily removed for inspection or repairs. A brush holder may be removed without dismantling the motor.

The brush stud is insulated from the brush yoke by special telescoping composition insulators shown above. These insulators provide most effective protection against grounds.

More details are given in Bulletin 200.

RELIANCE ELECTRIC & ENGINEERING CO.
1080 Ivanhoe Rd., Cleveland, Ohio
Branches: Boston New York Buffalo Philadelphia Pittsburgh
Birmingham Cincinnati Detroit Chicago

Type T Heavy Duty
RELIANCE MOTORS
Direct Current

What is your job for Electric Heat?

Heating batches of compounds? Heating tanks of solutions or oils? Melting grease or metals? Heating ovens or keeping pipe lines from freezing? Or heating hard-to-heat places in the plant? Single heat or 3-heat jobs .... low heat or up to 1100 degrees F? Chromalox Units are operating on these and a hundred other jobs .... three and four years at a stretch!

Certain of the 80 sizes of Strip Heaters, 8" to 72" long .... 9 diameters of Ring Units, 3" to 11" .... or 32 sizes of Immersion Units—quickly shipped from stock—are sure to fit your applications. *Why not send along a sketch or blueprint or outline in a letter what you want electrically heated?*

The Railway Utility Company of Chicago is sole distributor of Chromalox Strip Heaters for use in heating railroad and street cars in the United States and Canada. Sole Canadian Licensee: The Canadian Chromalox Co., Ltd., 251 Queen Street, East, Toronto, Ontario, Canada

Mail with your letterhead!

Send Bulletin C-106 telling about Chromalox Strip, Space, Ring and Immersion Units, and C-108 about Chromalox Electric Heaters—Vertical, Horizontal and Portable types.

We need Electric Heat for ISE-12-27

_____

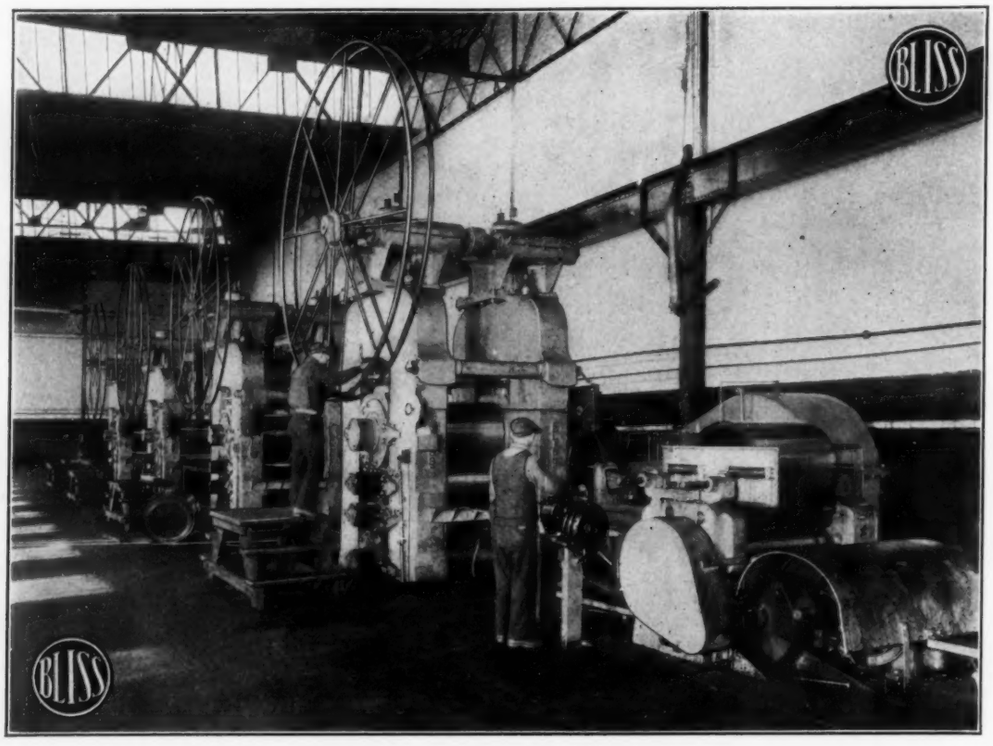
_____

Signed_____ Position_____

CHROMALOX HEATING UNITS

MANUFACTURED EXCLUSIVELY BY

EDWIN L. WIEGAND CO., 422 FIRST AVENUE, PITTSBURGH, PA.



BLISS MILLS
FOR
HOT *and* COLD ROLLING

The above illustration shows our mills in operation

AT COLUMBIA STEEL CO., BUTLER, PA.
ROLLING STRIP SHEETS

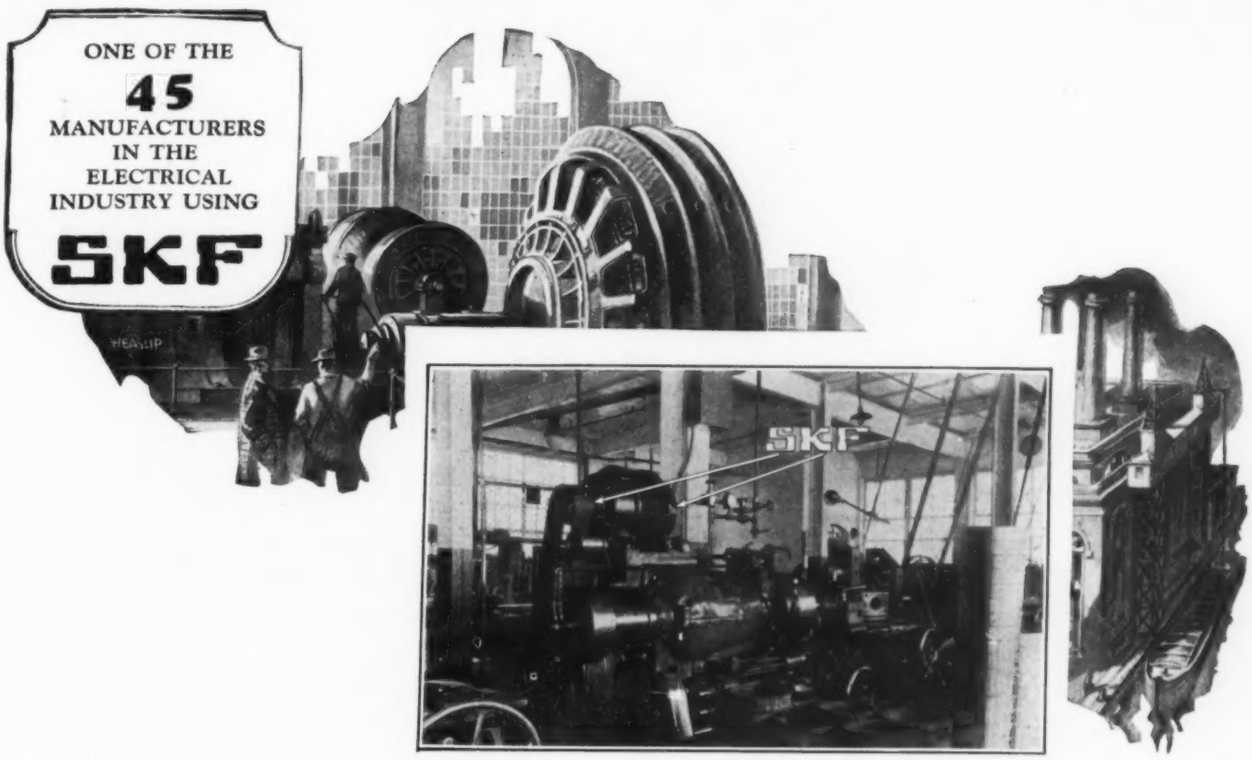
They are equipped with Roller Bearings, (Jones special type mounting—Patent Pending), on necks of work rolls as well as supporting rolls.

Similarly equipped, your present hot or cold mills will show a very considerable saving in your power bill.

We will be pleased to discuss with you this and other mill details.

Catalog on request.

E. W. BLISS CO. BROOKLYN, N.Y.
SALEM, OHIO.



Ten H. P. or 500, the Smooth Operation and Low Upkeep of SKF Remain Unchanged

Certified Survey No. 1833 in your Industry or one closely related to it Sent on Request.

As one electrical superintendent puts it:

"IT'S not the generating units nor the blooming mill units that cause most of our trouble. It's the little motors, in out of the way places, that always seem to burn up when they are needed most."

And these small motors keep your stockroom filled with spare parts and always seem to keep your electricians busy. But this condition is not true when small motors are equipped with SKF Self-Aligning Ball Bearings.

These bearings are self-contained and require no adjustments. Their self-alignment compensates for inaccuracies in set-up. Lubrication once every six months reduces maintenance costs to almost nothing. Exact interchangeability decreases your spare parts. And most of all they make your motors dependable.

Specify SKF bearings in your next motors. Or ask us how to change over your present ones.

SKF INDUSTRIES, INCORPORATED
40 East 34th Street, New York, N. Y. 1833

Ball Bearings **Roller Bearings**

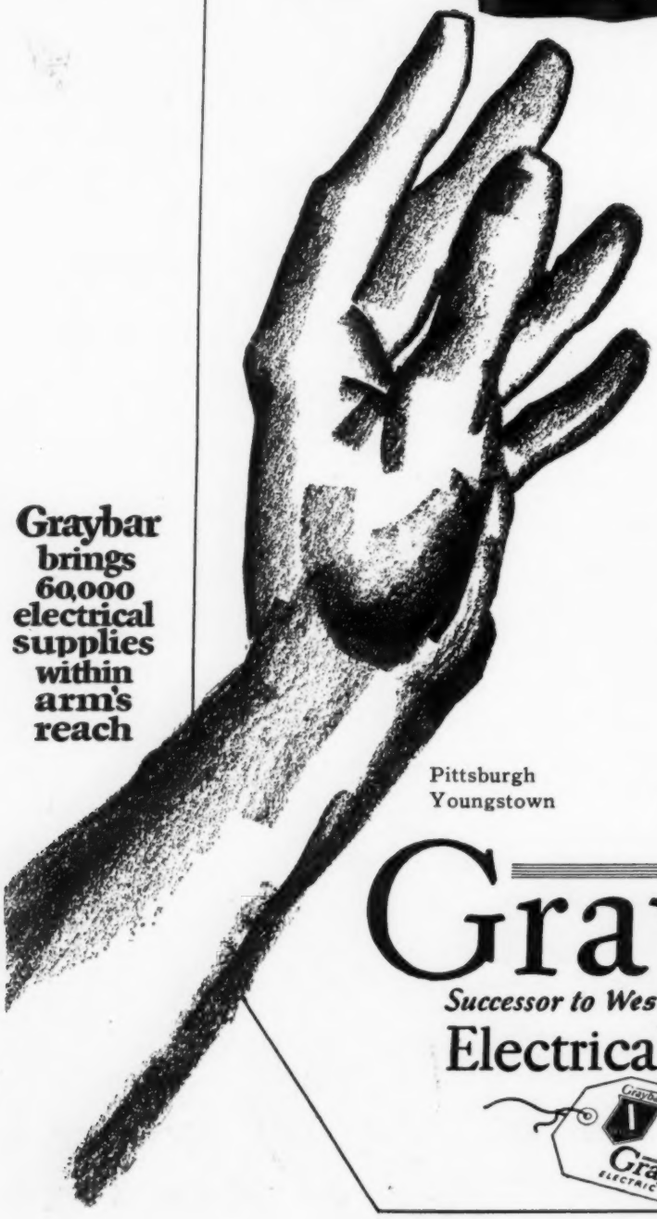
Buy Christmas Seals

– motors, too

Whatever motors you need, Graybar brings them within arm's reach. Motors and many other things—control and wiring supplies to put them to work— Graybar brings them all within arm's reach —some 60,000 electrical items.

Truly a great service, made possible only by Graybar's 63 distributing houses, located in principal cities the country over.

A group of individual drive motors, furnished by Graybar, on automatic machines making metal tire parts in the plant of Rex Products Co., Cleveland, O.



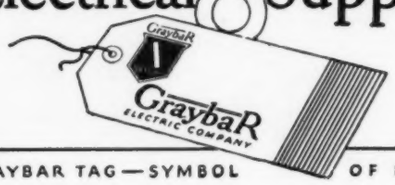
Graybar brings 60,000 electrical supplies within arm's reach

Pittsburgh Youngstown | Chicago Cleveland | New York Buffalo

GraybaR

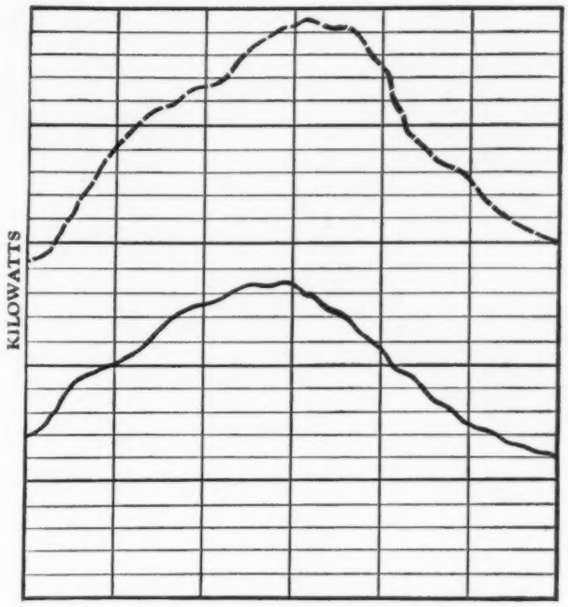
Successor to Western Electric Supply Dept.

Electrical Supplies



THE GRAYBAR TAG—SYMBOL OF DISTRIBUTION

MAXIMUM DEMAND!



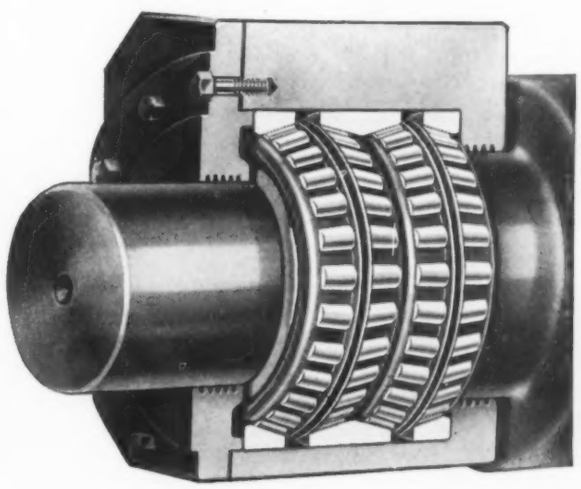
COMPARATIVE MAXIMUM DEMAND CURVE

Does Maximum Demand Affect Your Production?

WHERE steel plants have a large rolling mill load, the production schedule must often be arranged to fit maximum power demand limitations, which may be set either directly, or indirectly. Usually, the effective capacity of the mill suffers, because either some rolling equipment must stand idle waiting for off-peak hours, or else other machines must be shut down so that the mills may run without exceeding the demand limitations. The effect of such conditions on operating economy needs no emphasis.

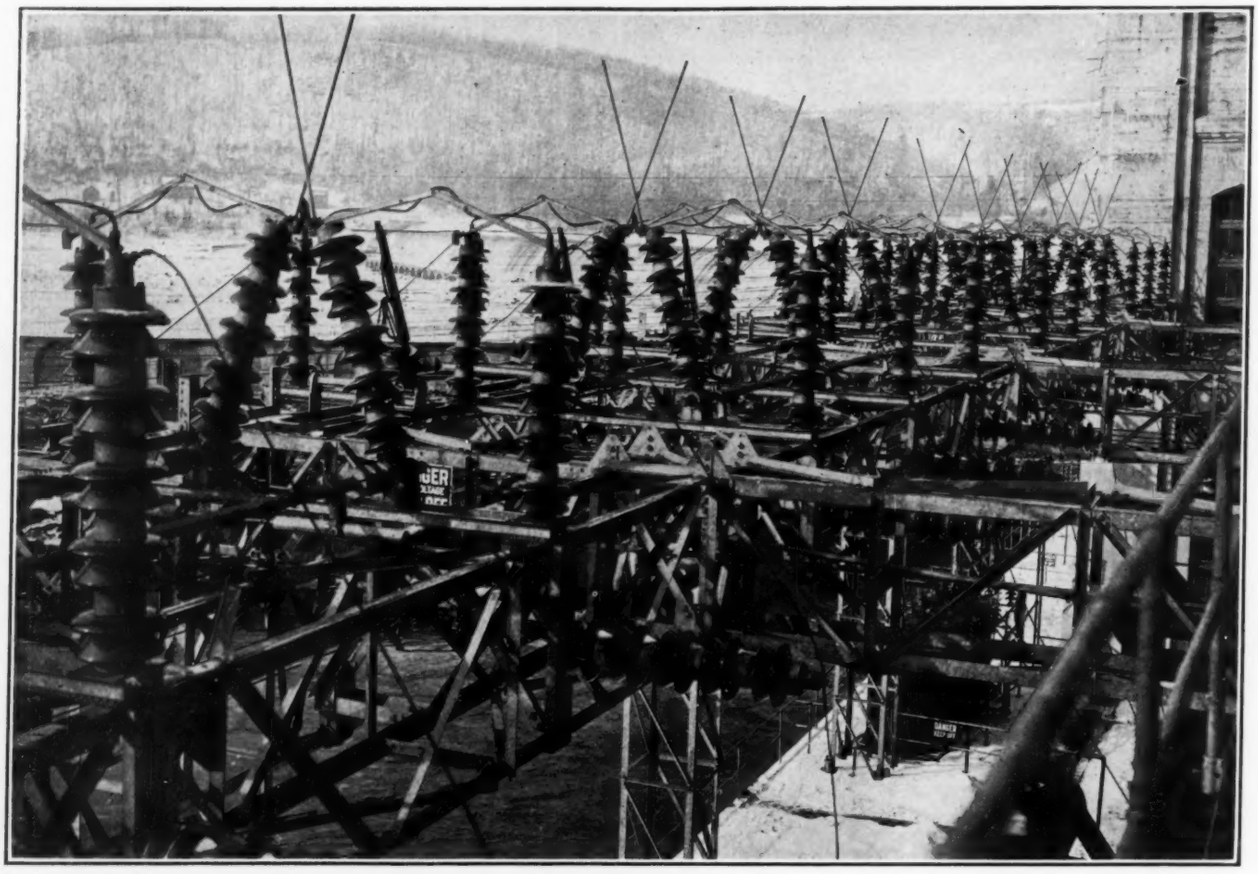
By installing TIMKEN TAPERED ROLLER BEARINGS on the mill roll necks, the situation is remedied by the process of elimination. The power demand of the mills is reduced by 40 to 50 per cent, to a point, in fact, where maximum demand ceases to be a factor in operation. All equipment can be worked simultaneously, without regard to individual power requirements, and the plant is made 100 per cent effective. As a result, both the speed and volume of production are increased, with a corresponding decrease in overall operating costs.

TIMKEN BEARINGS for this service, because of their tapered construction, *POSITIVELY ALIGNED ROLLS* and Timken-made electric steel, possess additional advantages both from an operating and an economical standpoint. Their use means that motors of much smaller horsepower ratings can be used for rolling mill drive, that overall power consumption is reduced, and that delays from shutdowns arising from bearing trouble are practically negligible. Furthermore, the factors that go to make up bearing maintenance expense are either minimized, or eliminated altogether, lubrication expense is decreased to about one tenth of its former figure, and bearing life greatly increased.



THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

TIMKEN
Tapered
ROLLER BEARINGS



Speaking of Hydros

Here's a snapshot looking down on a 110,000 volt hydro substation.

The most prominent thing in the picture is the most prominent substation earmark . . . the Elpeco Horn Gap Switches.

Involving the same principles of operation Elpeco Horn Gaps are at work up to 220,000 volts, and down to 11,000.

. . . all chosen "for the good of the service."

for the good of the Service *L. P. Cox*

ELPEC

ELECTRIC POWER EQUIPMENT CORPORATION

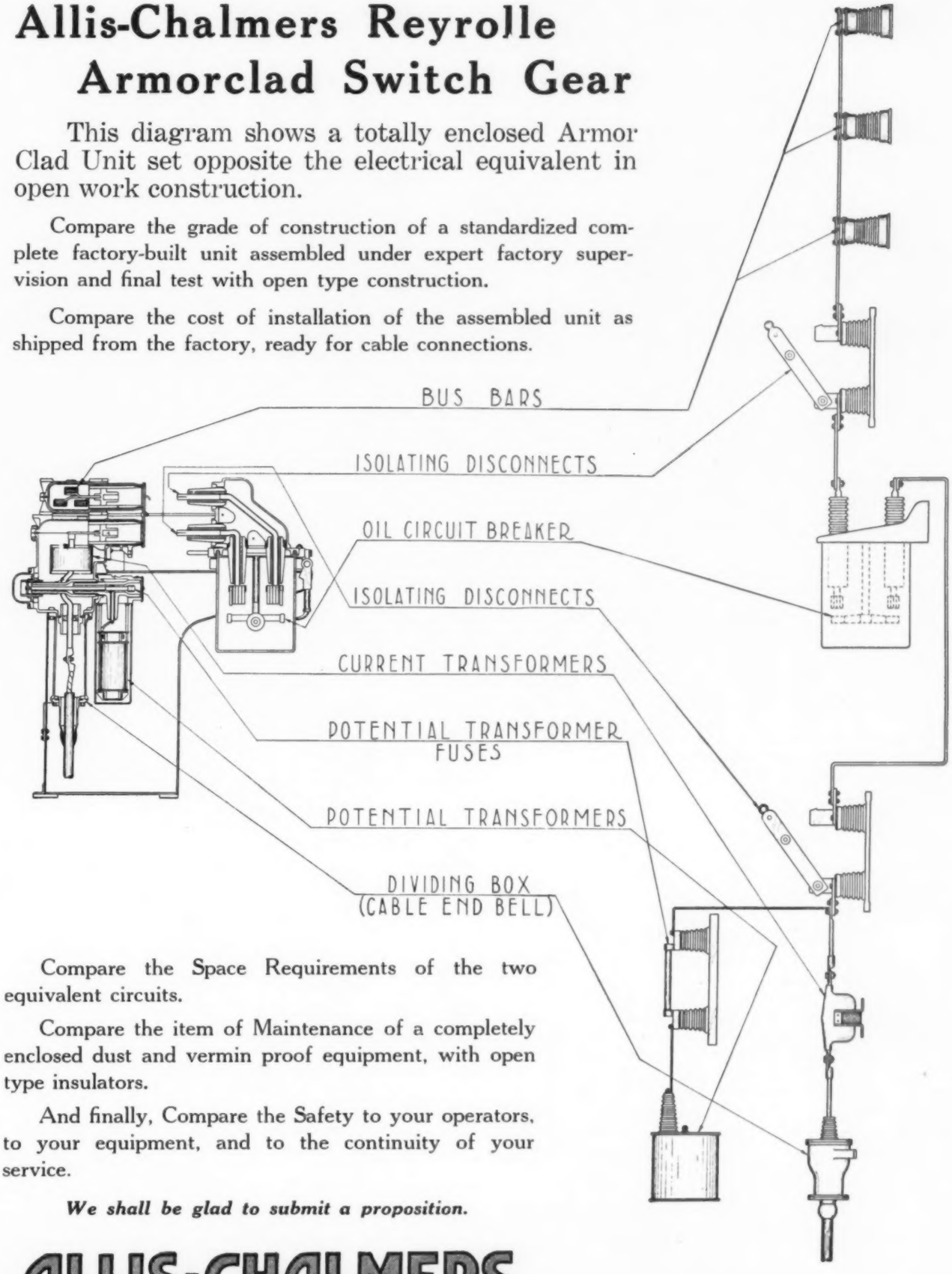
412-420 NORTH EIGHTEENTH ST. PHILADELPHIA, PA.

Allis-Chalmers Reyrolle Armorclad Switch Gear

This diagram shows a totally enclosed Armor Clad Unit set opposite the electrical equivalent in open work construction.

Compare the grade of construction of a standardized complete factory-built unit assembled under expert factory supervision and final test with open type construction.

Compare the cost of installation of the assembled unit as shipped from the factory, ready for cable connections.



Compare the Space Requirements of the two equivalent circuits.

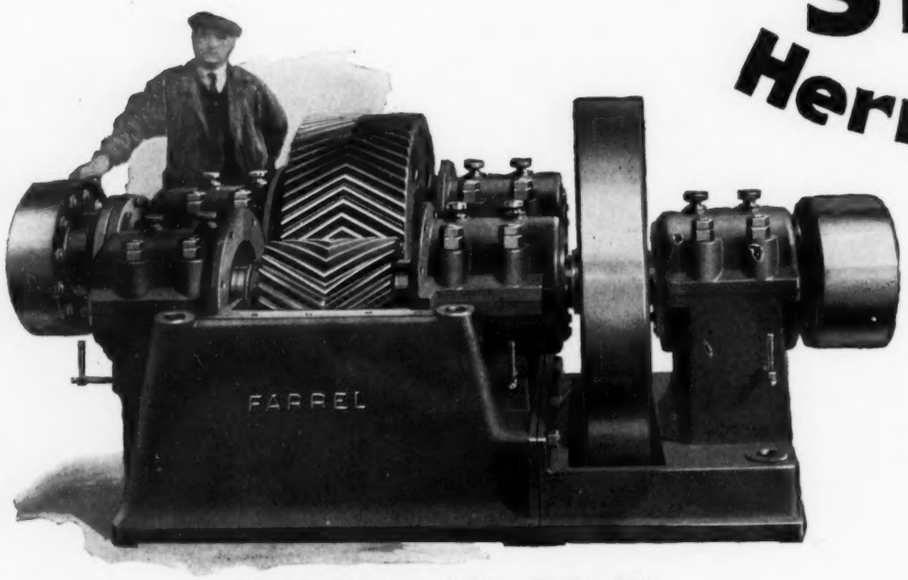
Compare the item of Maintenance of a completely enclosed dust and vermin proof equipment, with open type insulators.

And finally, Compare the Safety to your operators, to your equipment, and to the continuity of your service.

We shall be glad to submit a proposition.

ALLIS-CHALMERS
MILWAUKEE, WIS. U.S.A.

FARREL SYKES Herringbone



500 H.P. Unit for Driving a Rolling Mill

SPECIAL DESIGNS STANDARD GEAR UNITS or GEARS ONLY

The unit shown above is one of our series of standard units adapted to suit special conditions in a steel mill.

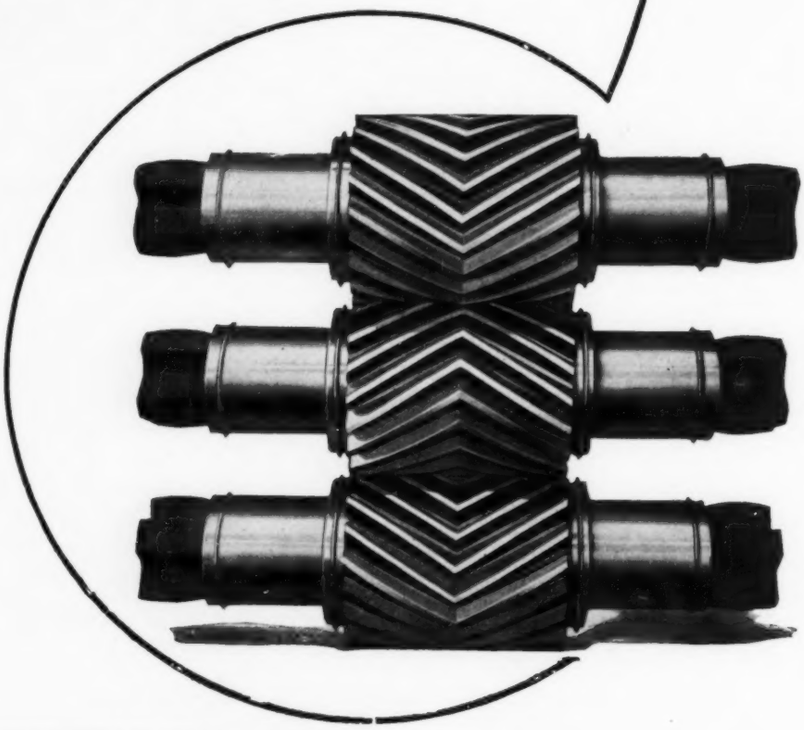
Advantage should be taken of our engineering service because we often find the same problem arising in different localities.

The unit illustrated transmits 500 H.P. from 780 to 225 R.P.M. and has already shown itself capable of transmitting a momentary overload of about 200%.

MILL PINIONS

In addition to our series of enclosed drives we supply mill pinions up to 1 D.P. and 28" face made of cast steel, forged steel, or hardened alloy steel.

They are at least 40% stronger than other types and by reason of the helix angle of 30° will transmit loads uniformly and will not deteriorate from the effect of shock.



SPECIFY THE GEAR WITH A BACKBONE

FARREL-BIRMINGHAM CO., INC.

SUCCESSORS TO
FARREL FOUNDRY & MACHINE CO, ANSONIA, CONN. AND
BUFFALO, N.Y. AND BIRMINGHAM IRON FOUNDRY OF DERBY, CONN.
ADDRESS REPLIES TO THIS ADVERTISEMENT TO BUFFALO PLANT
344 VULCAN ST., BUFFALO, N. Y.

A Baker Tractor is literally a locomotive compressed to packing-case size. It can be used to shunt freight cars, pull a long chain of trailers, push heavy machinery—a hundred and one jobs every day in any plant.

An eastern railroad put one Baker Crane in its shops and records showed that immediately locomotive repair costs were reduced 75%.

In a Warren, Ohio, steel plant, Baker trucks radically cut handling costs and actually increased the production of the plant. Strip had formerly piled up at one mill faster than men and hand-trucks could carry it away, and the mill had to be shut down periodically. One Baker Truck now handles the full capacity of two mills working full time.

It's nothing uncommon for a Baker Hy-Lift Truck to add 30% to warehouse capacity, by making higher stacks possible, and at the same time reduce material handling costs 75%. The Baker lifts 6000 lb. loads 72 inches.

1 Baker, 1 Hour =5 Men, 5 Hours

THAT'S the experience of a certain Baker user—a Baker Truck on his receiving platform *released 25 men for productive work.* It entirely paid for itself in 30 days.

Baker savings—almost unbelievably great as they are—are *provable* savings. Your cost sheets show them, and so does the larger net profit they make possible.

Baker Trucks, Tractors and Cranes will save 75% of material handling costs. They are as necessary, as profitable in the small shop as in the large. Specially designed for industrial use, they thread crowded narrow aisles, take sharp turns and high grades easily, and do the work of a locomotive all day, every day, for years—always on the job.

The fact that 98% of all vital parts of Baker Trucks, Tractors and Cranes are standardized and interchangeable makes for economy and ease in servicing. Yet that word is scarcely known among Baker users—hundreds of these trucks and tractors have been in constant use 8 and 10 years with scarcely a day off.

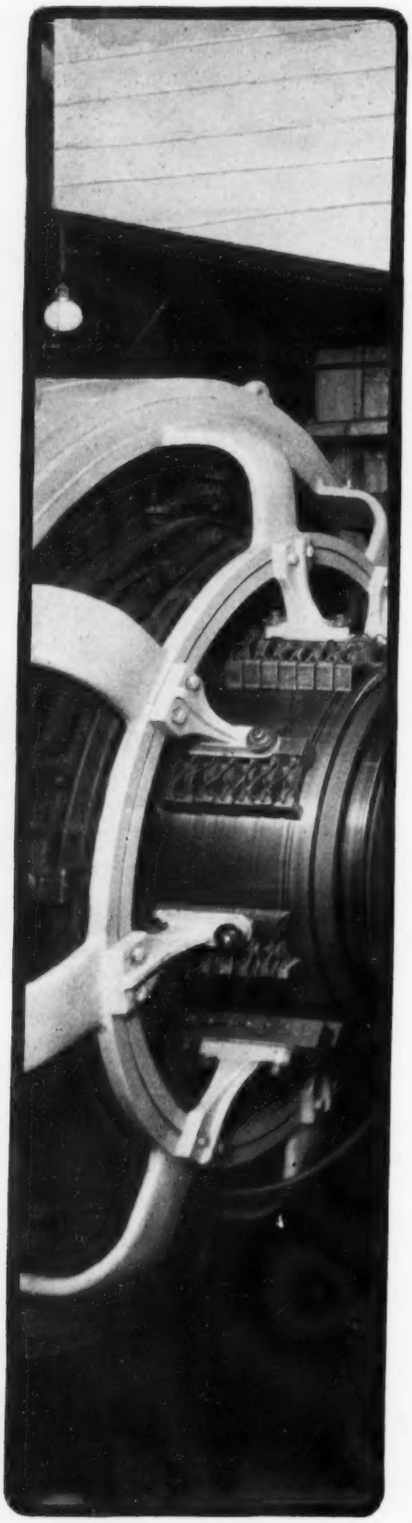
The Baker method of material handling is the accepted economical method today, and Baker Trucks and Tractors are the biggest dividend-paying tools or machinery you can buy.

ELECTRIC TRACTORS AND TRUCKS

Baker

New catalogue, No. 35, is yours for the asking

THE BAKER-RAULANG CO. · *2180 West 25th Street, Cleveland, Ohio*



Boxill-Bruel Brushes

take care of the business end of your generators and motors

Boxill-Bruel designs and makes up brushes to meet the exact demand of each machine. Our engineering department studies your requirements and meets them with brushes that are most efficient for the individual piece of equipment.

But this is not the limit of our interest in your machines. You are furnished a complete history of each and a key number for the brush necessary. We keep a similar record and it is very easy to duplicate the brush on any of your machines.

Think what this means to you, especially in an emergency. No guess work, no unnecessary loss of time but just referring to your records for complete information which permits you to order duplicate brushes on short notice.

We will be pleased to demonstrate the economy of this system at your suggestion. Fill in the coupon or write for further details!

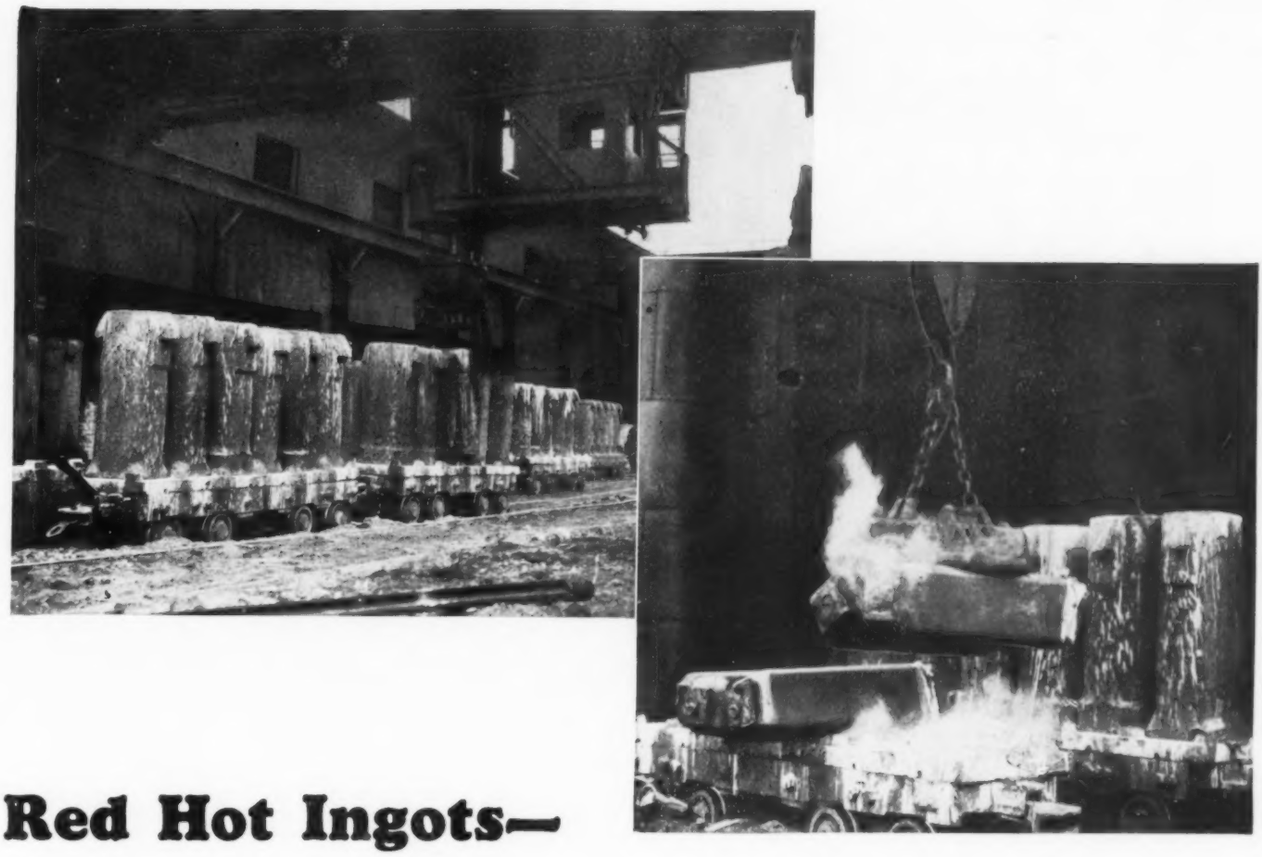
BOXILL-BRUEL CARBON COMPANY
COLUMBIA PARK, OHIO

Helps for the Engineer—Check

Please send me—

[ ] Engineering Data Sheets.
[ ] Code Sheets.
[ ] General Catalog.

NAME.....
FIRM.....
ADDRESS.....



Red Hot Ingots—

fresh from the stripper!

Type SA Lifting Magnet

Steel ingots, so hot that they set the air shimmering, some of them just turning black from red, are being lifted from the buggies where the stripper crane has left them. Long before they have cooled so that a man can approach them, the crane operator picks them up with his lifting magnet and carries them to the storage pile.

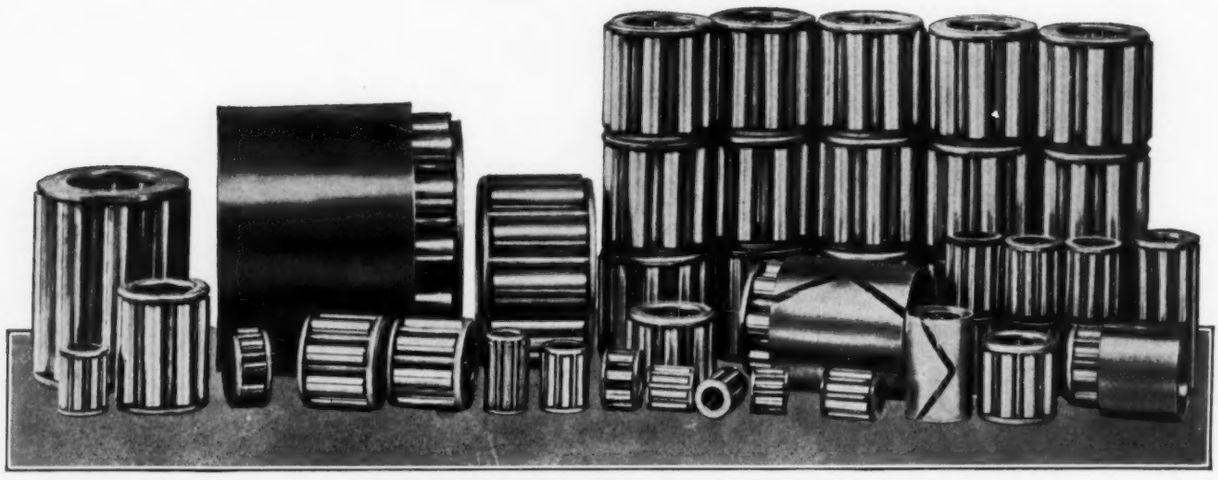
Regardless of this great heat and, too, of the rain that was falling when this picture was taken, this 65" EC&M Lifting Magnet goes right on handling these 9,800 pound ingots without complaint or sign of distress. EC&M Lifting Magnets are built for such service.

Write for our Bulletin 900 describing
EC&M Lifting Magnets

THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, OHIO

BIRMINGHAM - BROWN-MARX BLDG.
CHICAGO - CONWAY BLDG.
CINCINNATI - 1ST NATIONAL BANK BLDG.
DETROIT - DIME BANK BLDG.
NEW YORK - 50 CHURCH ST.
LOS ANGELES - 912 E. THIRD ST.
SALT LAKE CITY - 228 SO. W. TEMPLE
PHILADELPHIA - WITHERSPOON BLDG.
PITTSBURGH - OLIVER BLDG.
SAN FRANCISCO - CALL BUILDING
MONTREAL - DRUMMOND BLDG.
TORONTO - REFORD BLDG.



Typical Group of Rollway Wide Series and Utility Bearings

ROLLWAY CYLINDRICAL ROLLER BEARINGS

for Heavy Industrial Service

For more than 18 years the Rollway organization has specialized in the design, manufacture and application of Cylindrical Roller Bearings to railway and heavy industrial service. The principal classes of bearings which we are now making are listed below:

Maximum Type Radial Bearings — Sixteen types of Heavy-Duty Precision Bearings in sizes interchangeable with annular ball bearings or with metric sizes of roller bearings. ***Catalog 3-A***

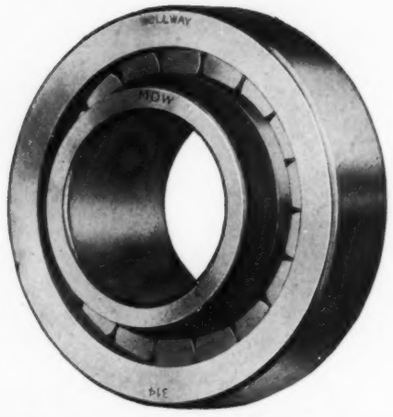
Roller Thrust Bearings — Six types of Heavy-Duty Bearings, single-acting and double-acting, with and without aligning washers. ***Catalog 3-A***

Crane Hook Thrust Bearings — Large capacity long life hook bearings permit loads to swivel freely under heaviest loads. ***Bulletin No. 51***

Wide Series and Utility Types — Seven types, with various combinations of inner and outer sleeves. Five of these types designed for rollers operating directly on shaft. ***Catalog 4-A***

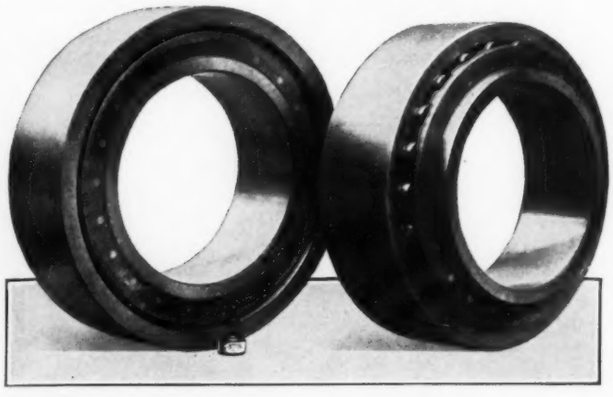
Roll Neck Bearings — Large Heavy-Duty Bearings specially designed for steel or brass rolling mills, oil mill crushing rolls, or calendar rolls for rubber mills or paper mills. ***Bulletin No. 52***

Roller Bearing Pillow Blocks — Self-aligning pillow blocks for shafting from $1\frac{3}{16}$" to $8\frac{3}{4}$" diameter. ***Bulletins No. 53 and No. 55***



Maximum Double Width Bearing, Full Roller Type, with Wide Inner Race to Give Ample Seat on Shaft

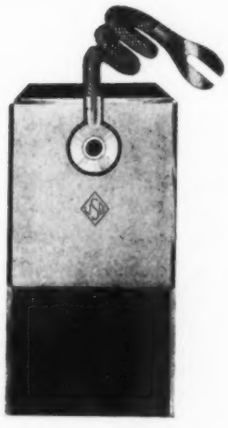
Single Acting, Flat Washer Type Roller Thrust Bearing



Rollway Bearing for Roll Neck—Estimated Capacity One Million Pounds

Rollway Bearing Co., Inc.
Syracuse New York

BRUSHES AND CONTACTS



Dependability

There are several reasons for the renowned dependability of U. S. G. Brushes and Contacts. They are completely manufactured from the raw material to the finished brush in one plant under the supervision of trained brush engineers. The most important basic element entering into their manufacture — graphite — comes from mines owned and operated by this company. Each grade is specifically designed for the service for which it is intended.

The result is that U. S. G. Brushes can absolutely be depended on to meet every operating condition successfully and economically.

There is a U. S. G. representative near you. Let us have him call and demonstrate why U. S. G. Brushes are better.

Have you a copy of our "Carbon Products" catalog? Write for it.

The
United States Graphite Co.
Saginaw - - - Mich.

—and NOW! the "Circle T" 60 AMP. "R. M."

The "R.M." (Rotor Movement) line of Switches was designed and developed by "Circle T" in 1925. Up until this time this line was confined to 30 Amp. Switches.

We are now announcing 60 Amp. "R.M." Switches in 250 and 600 Volt sizes.

The same exclusive features built into the 30 Amp. Switches are incorporated in the 60 Amp. Switches.

They are as follows:

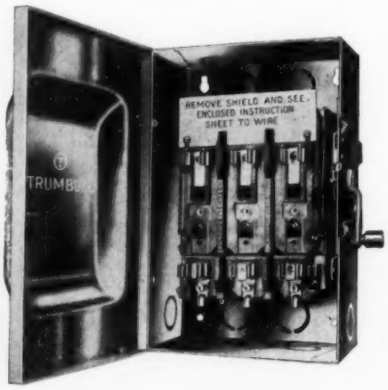
1. Small in size.
2. Double break construction.
3. Strength compares in every way to Type "A" Switches.
4. All live parts out of reach while fuses are being renewed.
5. It is simply necessary to loosen two screws in order to remove the entire switch and operating mechanism when wiring.

The 60 Amp. Switches are made in the following types—Fusible and No Fuse, 2, 3, and 4 Pole, both 250 and 600 Volts.

Two Position Motor Starting Switches, 2, 3, and 4 Pole, 250 and 600 Volts.

The "R.M." Type of Switches are peculiarly suitable for use in mounting directly on machines.

The compactness in size, ease of operation and low price has induced many machinery manufacturers to furnish this type of switch with the machine itself.



Cut shows the 3-Pole 600 V. A.C., 60 Amp., Two Position Motor Starting Switch.

No. 94362

"Circleteed is Guaranteed"

The Trumbull Electric Mfg. Co.
Plainville, Conn.

New York Chicago San Francisco Boston Philadelphia
Atlanta Ludlow, Ky.

No more Missing Lamps

No more Empty Sockets

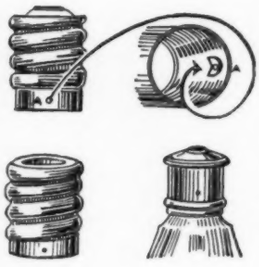
THE LAMP THAT CANNOT BE STOLEN

—o—

KULP THEFT PROOF

—o—

STANDARD LAMPS
STANDARD SIZES AND VOLTAGES



Kulp Theft Proof Lamps can only be removed from a socket by breaking the glass. Then the screw base can be reached and unscrewed. This operation is simple and easy. Since the lamp can only be removed by breaking it, there is no incentive to theft.

The distinctive and exclusive feature of the Kulp Lamp bulb is that the lamp itself contains the theft-proof feature.

J. H. OVERPECK CO.

412 House Building

PITTSBURGH PENNA.

Made by Westinghouse E & M Co.

Made by General Electric Company

In Life-long Partnership with "WESTONS"

Weston has been far more than a mere **supplier** to the Electric Power Industry during the past forty years. By invitation, we have been privileged to sit in its inner councils, developing the necessary instruments to serve its needs, step by step, throughout the **entire period** of its history. The industry in all its branches—laboratory, manufacturing and power equipment operation—has brought its various testing problems to us to be solved. Our mutual relations have been more like a partnership, in which Weston's responsibility has ever been **extreme accuracy and reliability of the test result.** This explains why the second and third generations of engineers are reluctant to experiment with other instruments.

The JUNIOR Line

These instruments, incased in heavy Bakelite, meet every need for portable A. C. testing in the plant or out in the field. Especially designed for such requirements as are met with in general mining, engineering and railway work where **next to laboratory accuracy** is desired. Made as Wattmeters, Voltmeters, Ammeters and Milliammeters. Every Weston quality feature is employed, such as shielding, mirror scales and knife-edge pointers of trussed construction, special air damper design, zero correcting device, etc. These instruments have exceedingly small frequency, phase angle, temperature and working errors, and may be left in circuit continuously without undue heating or indication errors. Write for Bulletin 2006.

WESTON ELECTRICAL INSTRUMENT CORPORATION
199 Weston Ave. Newark, N. J.

Model 432 A.C. **Model 433 A.C.**

Weston
PIONEERS SINCE 1888
INSTRUMENTS

An Impenetrable Surface

Protect the life of your furnaces against the destructive demons of Abrasion, Steam Erosion and Slag Penetration with Queen's Run Firebrick—the Firebrick that lasts.

Combine the inherent fire-resisting advantages of Queen's Run Firebrick with the skill and knowledge that comes with 91 years experience and you have the reason why Queen's Run Firebrick is America's first and foremost Firebrick.

Let our long experience in furnace firebrick help you on your next furnace.

Queen's Run Refractories Co., Inc.
LOCK HAVEN PENNA.

Boston Office, 141 Milk St. New York Office, 15 Park Row
Philadelphia Office, 602 Harrison Bldg.

Queen's Run

Bouth Hai

In Malabar, the general India customs are largely reversed.

It is there that wives get the big deal.

Inheritance goes through the female line and she takes her husband, and keeps him if he acts right.

If he doesn't, she gets rid of him by simply uttering *bouth hai*, which is the equivalent of Shakespeare's "Out naughty spot," and she takes unto herself a more fitting worker.

There is no more formality connected with it than that of the operator who seeing that he has made a poor choice of carbon brushes, simply gives them the air and adopts the more tractable kind—Morganite.

Both get peace at the irreducible minimum of cost and trouble.

Morganite

Main Office and Factory
3302-3320 *Anable Ave., Long Island City, N. Y.*

DISTRICT ENGINEERS AND AGENTS

Pittsburgh, Electrical Engineering & Mfg. Co., 909 Penn Avenue.
Cincinnati, Electrical Engineering & Mfg. Co., 607 Mercantile Library Building.
Cleveland, Electrical Engineering & Mfg. Co., 422 Union Building.
Baltimore, O. T. Hall, Sales Engineer, 437-A Equitable Building.
Revere, Mass., J. F. Drummey, 75 Pleasant Street.
Los Angeles, Electrical Engineering Sales Co., 502 Delta Building.
San Francisco, Electrical Engineering Sales Co., 222 Underwood Building, 545 Market Street.
Toronto, Can., Railway & Power Engineering Corp., Ltd., 101 Eastern Ave.
Montreal, Can., Railway & Power Engineering Corp., Ltd., 326 Craig St., West.
Winnipeg, Can., Railway & Power Engineering Corp., Ltd., P. O. Box 325.

1891 — 1927

MORGAN
Construction Co.

Worcester, Mass., U. S. A.

Designers and Builders of

Morgan Continuous Mills

for

Billets, Sheet Bars, Skelp, Merchant-Bars, Hot--Strip, Rods

also

Wire Drawing Machines
Producer-Gas Machines
Straightening Machines
Isley Furnace Control
Re-Heating Furnaces
Reducing Gear Units
Shears

Our Engineering Department

is prepared to solve successfully your problems in design or arrangement of plant and equipment from open hearth to finished product.

1891 — 1927

Distributors for the Following Lines:

Westinghouse Electric & Manufacturing Co.
- Fans
- Lighting Equipment
- Safety Switches
- Panelboards
- Motors and Control Meters
- Transformers
- Line Material
- Insulators
- Lighting Arrestors
- Insulating Material and Other Supplies

Westinghouse Lamps
Crouse Hinds Condulets
Erie Malleable Kondu Boxes
Black & Decker Portable Electric Tools
Rome Super-Service Cords and Cables
Bull Dog Safety Switches
Beaver Stocks and Dies
Hubbard Pierce Pole Line Specialties
Economy Fuses
Tork Clocks
National Metal Molding Conduit and Fittings
Steel City Electric Products
Central Tube Conduit
Klein Tools
P&S Wiring Devices
Cutler-Hammer Manfg. Co.
Hart & Hegeman Manfg. Co.
Harvey Hubbell, Inc.
National Carbon Co. Eveready Batteries, etc.
American Wiremold
Bryant Electric Co.
Breezo Ventilating and Exhaust Fans

Iron City Electric Co.

436-38 Seventh Avenue

Pittsburgh, Pa.

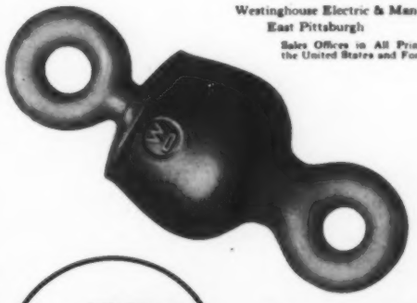
Balto's Endurance
Saved Nome

FIGHTING every inch of the way, through a blizzard which obliterated all landmarks and signs, Balto led his team-mates on to the epidemic-stricken city of Nome. Behind were the medical supplies—the only hope of stamping out the plague. A hero's portion was his due.

Quietly, without the world's applause, Westinghouse Duro Strain Insulators, conquering weather and time, are saving the steel industry thousands of dollars each year, preventing shut-downs and line repairs. They cost so little that they make cheap insulators expensive.

The molded body of the Duro Strain Insulator never cracks or softens. Rain and sleet do not affect it. Heat cannot harm it. When Duro goes up, it stays for years.

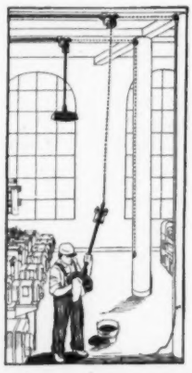
Westinghouse Electric & Manufacturing Company
East Pittsburgh Pennsylvania
Sales Offices in All Principal Cities of the United States and Foreign Countries



X98400

Westinghouse

DURO *Strain Insulators*



"Why up in the Air"—

—When reflectors can be cleaned more frequently, safely and thoroughly down on the ground?

They are worthless unless kept in a reflecting condition. Dirty reflectors do not reflect.

Why install a lamp where it cannot be cleaned at all —or only by the climbing process?

The THOMPSON Safety Lowering Switch or Disconnecting Hanger enables overhead lamps to be lowered away from the electric circuit for cleaning the reflectors or renewing bulbs. The advantage is obvious. The Hanger is inexpensive and easily included in present installations. For outdoor and indoor use.

Illustrated booklet and complete information on request.

THE THOMPSON ELECTRIC COMPANY
1438 West Ninth St., CLEVELAND, OHIO, U. S. A.

THOMPSON
SAFETY LOWERING SWITCH
or HANGER

"TOOL STEEL"
Quality
for
LONG LIFE

Coupling Boxes
Motor Pinions
Brake Wheels
Crane Wheels
Mill Pinions
Bushings
Spindles
Rollers
Gears

Production is not hampered if cranes and mills have "Tool Steel" gears and pinions.

THE
Tool Steel Gear & Pinion Co.
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FAWCUS-TIMKEN
WORM GEAR DRIVE

Embodying all the latest improvement in design. A combination of the best materials and workmanship in the industrial field—Fawcus Gears and Timken Bearings.

A new catalogue giving dimensions, horsepower and efficiency of all standard sizes of FAWCUS-TIMKEN WORM GEAR DRIVES. Write for your copy of Bulletin "E."

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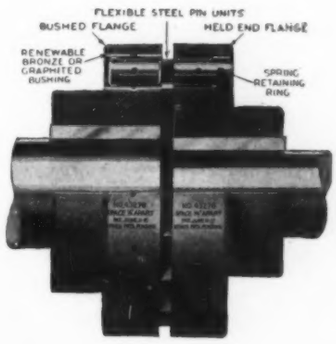
Better than a Francke coupling —an Improved Francke

The Improved

FRANCKE
FLEXIBLE COUPLINGS

These **bushed laminated-pin type** Francke couplings have these advantages: ¶Handle all accidental shaft misalignments. ¶Cushion load shocks and vibrations. ¶Provide for more and easier endwise displacement. ¶Carry their own lubrication for most usual drives. ¶Are more easily lined up and are easier to disconnect and assemble. Have greater bore and power capacity resulting in lower cost per unit.



More than five years ago the first of these improved Franckes were put into service on 24-hour per day drives. The increased operating satisfaction obtained lead to the redesign of all sizes. Twice during the last 18 months we have had to increase production capacity, and today we are making more satisfactory shipments of a better coupling.

May we send you bulletin giving data and prices?

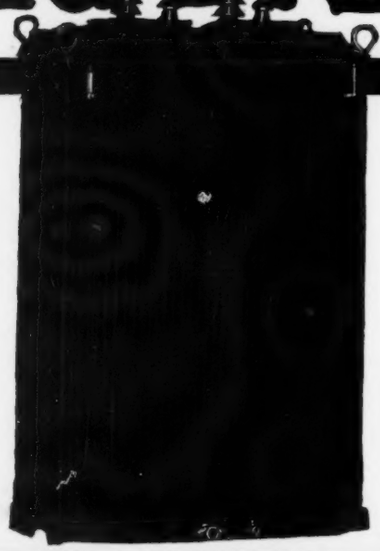
SMITH & SERRELL

Coupling Specialists Since 1912.

64 Washington St., Newark, N. J.

For extra misalignment capacity and for larger rolling mill drives use Double, Floating-Ring Type Francke couplings.

MOLONEY TRANSFORMERS



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Everything in Radio

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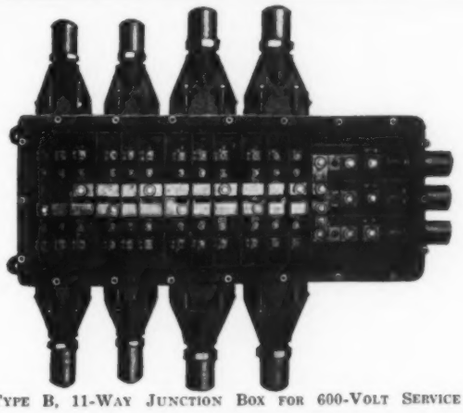
De Laval Worm Gear

A Superior Speed Reducer for Exposed Locations

Completely Self-Contained and Self-Lubricated

This 50 to 1 ratio gear transmits 5 HP. from a 900 R.P.M. motor to a vertical shaft pump. De Laval Flexible Couplings connect the gear to the driving and driven machines.

De Laval Steam Turbine Co., Trenton, N. J.



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Dependable and Economical Power Distribution

Forty-five years experience in the manufacture and installation of underground cables has convinced us that properly designed junction boxes are necessary to the profitable and continuous transmission of power underground.

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have been developed as a result of this experience and their exclusive and patented features insure a maximum degree of flexibility and dependability. Their protective and disconnecting features insure continuity of service and low maintenance cost.

If you are interested in effective junction boxes write our nearest office for Catalogue No. 720, just off the press.

Standard Underground Cable Co.

Division of General Cable Corp.

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THE popular Wheeler Durex Reflectors for Industrial Lighting, Vapolux Fixtures, "1300" Fixtures, Isolux Reflectors and other Wheeler units are now distributed and carried in stock by us.

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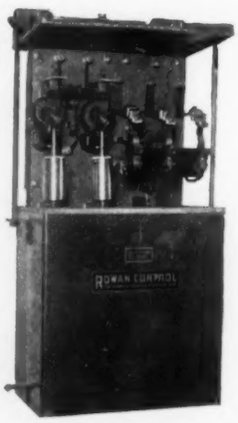

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THE ONLY COMPLETELY
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ACROSS-THE-LINE STARTING

THE STARTER TO USE WHERE THERE IS AN ABUNDANCE OF DUST, GAS OR CORROSIVE FUMES TO INSURE SAFETY AND SERVICE

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THE ROWAN CONTROLLER CO., BALTIMORE, MD.

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A Superior Speed Reducer
for Connecting High Speed to Low Speed Machinery
This 4-⅝ ratio gear is installed between a 2400 R.P.M. water turbine developing 14 H.P. and a Rotrex Air Pump
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You can have the same kind of dependable, economical electric headlights

Pyle-National headlights and turbo-generators are standard equipment on a great majority of railroads, not alone in this country but all around the world. They are used on the crack trains, and on switching engines, and for all classes of service in between.

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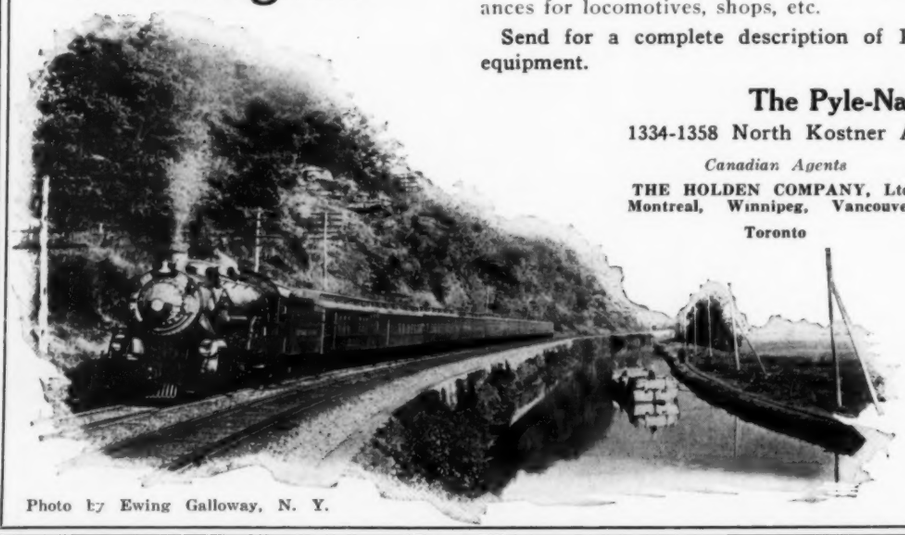
Send for a complete description of Pyle-National railway electrical equipment.



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228 of 100 Ton Capacity and over

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58	100 tons
2	115 tons
44	125 tons
27	150 tons
3	160 tons
1	165 tons
28	175 tons
2	200 tons
1	225 tons
1	250 tons
1	275 tons
3	430 tons

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8	100 tons
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21	150 tons
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1	Single Ram, 320 tons

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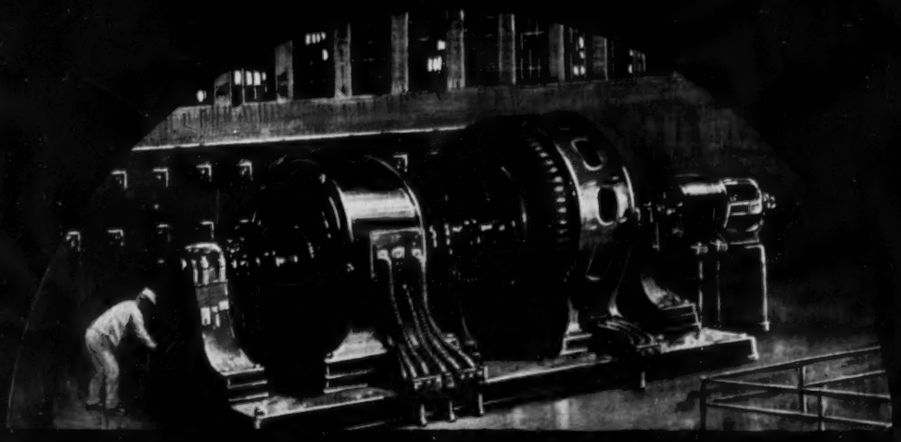

ECONOMY *renewable* FUSES

INDUSTRIES using electrical energy save 80% annually in fuse maintenance costs when they install Economy renewable Fuses in the place of "one-time" fuse-equipment.

Economy Fuse performance is a matter of record—they were the first fuses using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be *Approved in All Capacities* by the Underwriters' Laboratories.

Economy "Drop-Out" Renewal Links cost but little and make the restoration of a blown fuse the work of a moment only.

Your plant needs Economy Fuses. Investigate the quality of the electrical protection you now have from the standpoint of dependability, efficiency and economy.

Then order Economy Fuses installed.

For Sale by all leading Electrical Jobbers and Dealers.

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Save Open Hearth Fuel

The open hearth furnace wastes 80%
of the fuel consumed in the operation

The melting expense on open hearth furnaces has been reduced enormously and savings of $15,000 to $20,000 a year have resulted from the installation of

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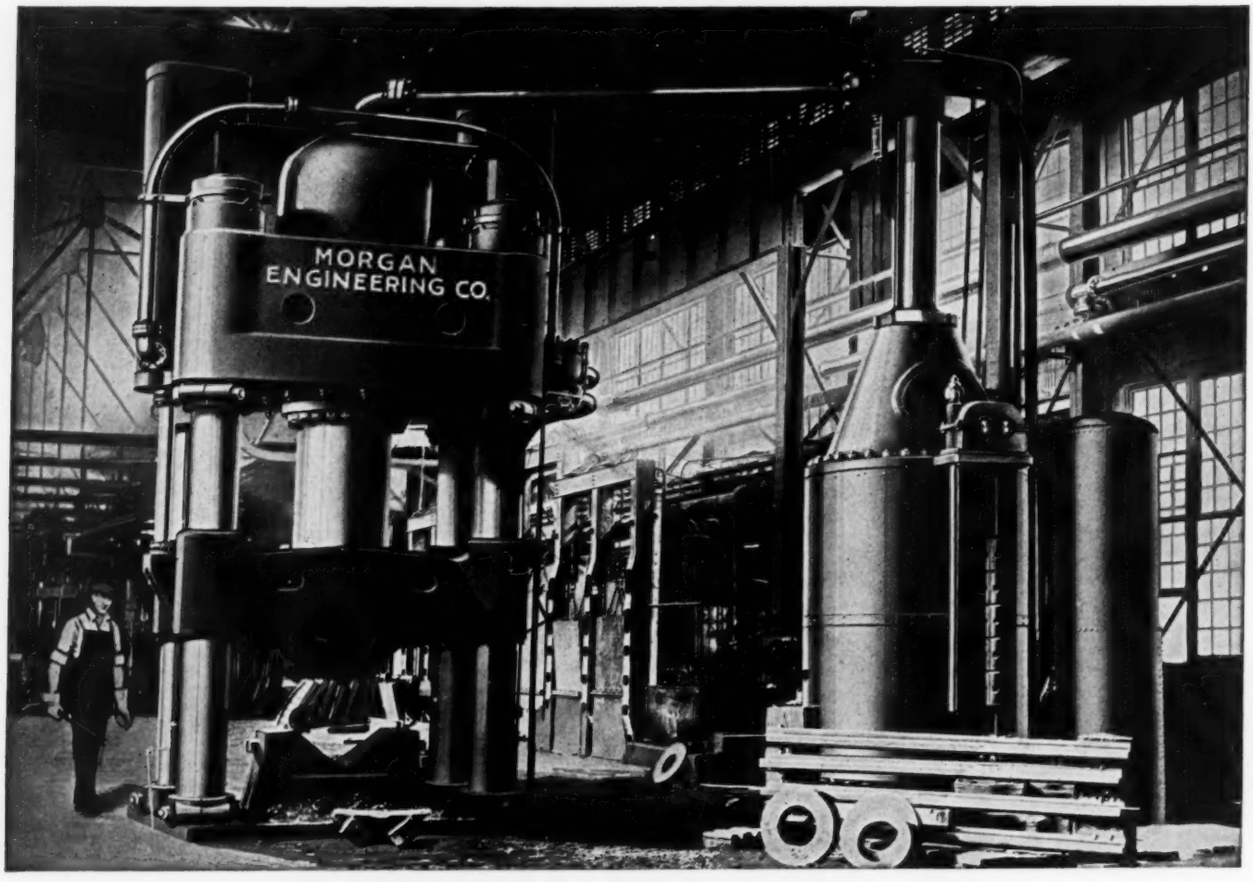
WITH THE FORGING INDUSTRY



MORGAN 2500-TON STEAM HYDRAULIC FORGING PRESS
Single Frame Types 150 to 500-Tons Capacity
Four Column Types up to 12,000-Tons Capacity

For more than fifty years Morgan has been closely associated with the Forging Industry.

Being the pioneer builder of steam hammers, it is but natural that the valuable experience thus gained should be incorporated into the High Speed Steam Hydraulic Forging Press as representing the most efficient and economical tool for producing solid and homogenous forgings.

The same superiority in design and high quality in material and workmanship, which has made Morgan Hammers famous, will be found in Morgan Forging Presses.

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Electric Traveling Cranes, Rolling Mill Machinery, Steam Hammers, Steam Hydraulic Forging Presses

Hydraulic Presses, Rock Crushers, Machine Work of all kinds, Special Machinery for any purpose.

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Says the Chief Engineer

"When I got my license back in '99, nobody thought much of combining bookkeeping with steam engineering. In those days the superintendent didn't come bothering a man about 'percentage of efficiency in production of steam'. Now, by George, they want to know exactly,—and you can't depend on instinct or on a fireman's guesses for that. No sir, rule of thumb is out of date. Today, with competition so keen, the motto is 'make every penny count.'

"I'm not kicking, though. They put in Republic Flow Meters and I can split decimal points with them now. Run my power plant like other departments?' says I. 'All right, gentlemen. The boiler room has nothing to lose from records.' Fact is, we gain. I was going to demand a new boiler, but by watching the meters I can distribute the load so we don't need it,—not this year. When we do, my records will get it for me.

"I got gray-headed guessing about steam, then worrying about my guesses. But I don't even 'estimate' any more, using Republic Flow Meters. I know."

P. S. The Accountant will talk to you next month.

"Bulletin Steam Economy Mailed on Request"

Republic Flow Meters Co.

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Helical Gears on a Rerolling Mill Drive

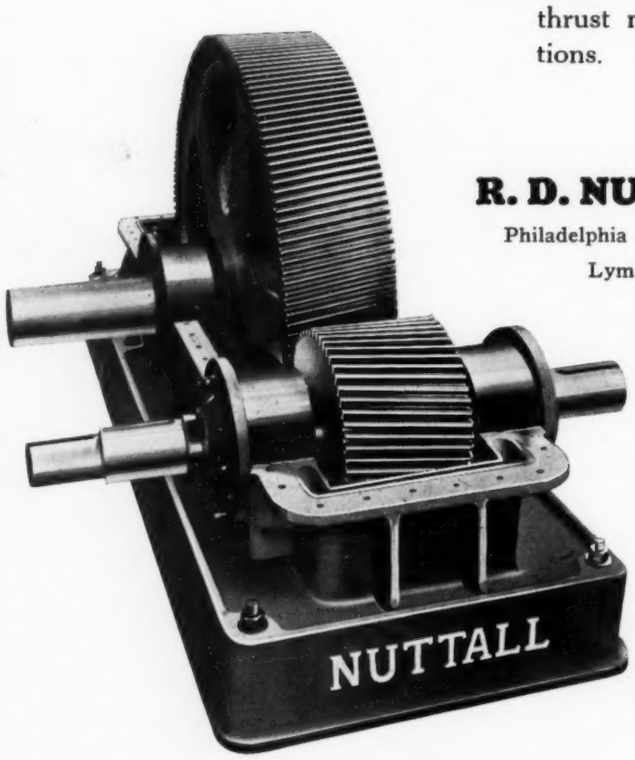
Single helical gears mounted on Timken Roller Bearings built into a standard Nuttall Mill type unit were chosen by one of America's largest industrial concerns to drive a rerolling mill for the tube mill in their steel plant. These gears are designed to transmit 1200 h.p. at a speed of 360 r.p.m. on the pinion shaft. They have a reduction ratio of 3.6:1, and are designed with a high overload capacity. Their great tooth strength, smooth operation, and superior wearing characteristics, coupled with their ability to withstand external thrust make helical gears ideal for such installations.

Send for our bulletin No. 54

R. D. NUTTALL CO., Pittsburgh, Pa.

Philadelphia Chicago Wilkes-Barre Los Angeles

Lyman Tube & Supply Co., Montreal, Canada



Nuttall MR 60 gear unit with upper case removed.

Nuttall

In These New and Better Lamp Guards

A new and important feature has been incorporated in the construction of Keystone and Pennsylvania Type Lamp Guards which practically eliminates all pull on the socket connections and does away with the necessity of tieing knots in the cord within the lamp guard handle. This is the New Cord Clamping Device. It presents the greatest single advance in the design of portable lamps in a long time, eliminating at once the greatest source of trouble experienced in the use of lamp guards, namely short circuits and poor contacts at the socket connections.

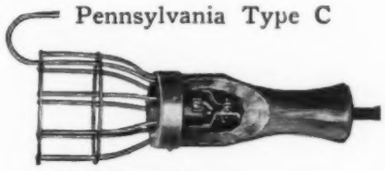
This feature is being incorporated in the Keystone and Pennsylvania type guards without advance in price.

These guards are well known for their ability to withstand rough usage, being made with heavy Bessemer Steel cages and maple wood handles. Now they offer you still greater service.

Write now for further information and net prices on your requirements for lamp guards. You may address any of the following offices:

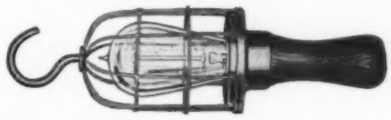
Home office and plant at 17th & Cambria Sts., PHILADELPHIA; district offices at 230 So. Clark St., CHICAGO; 50 Church St., NEW YORK; Bessemer Bldg., Pittsburgh; 88 Broad St., Boston; General Motors Bldg., Detroit; 316 N. Washington Ave., Scranton; Canadian Agents, Lyman Tube & Supply Company, Ltd., Montreal, Toronto, Vancouver.

Pennsylvania Type C



List Price $1.65—Reflector 10c

Keystone Standard Type



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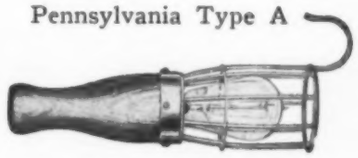
Pennsylvania Type A



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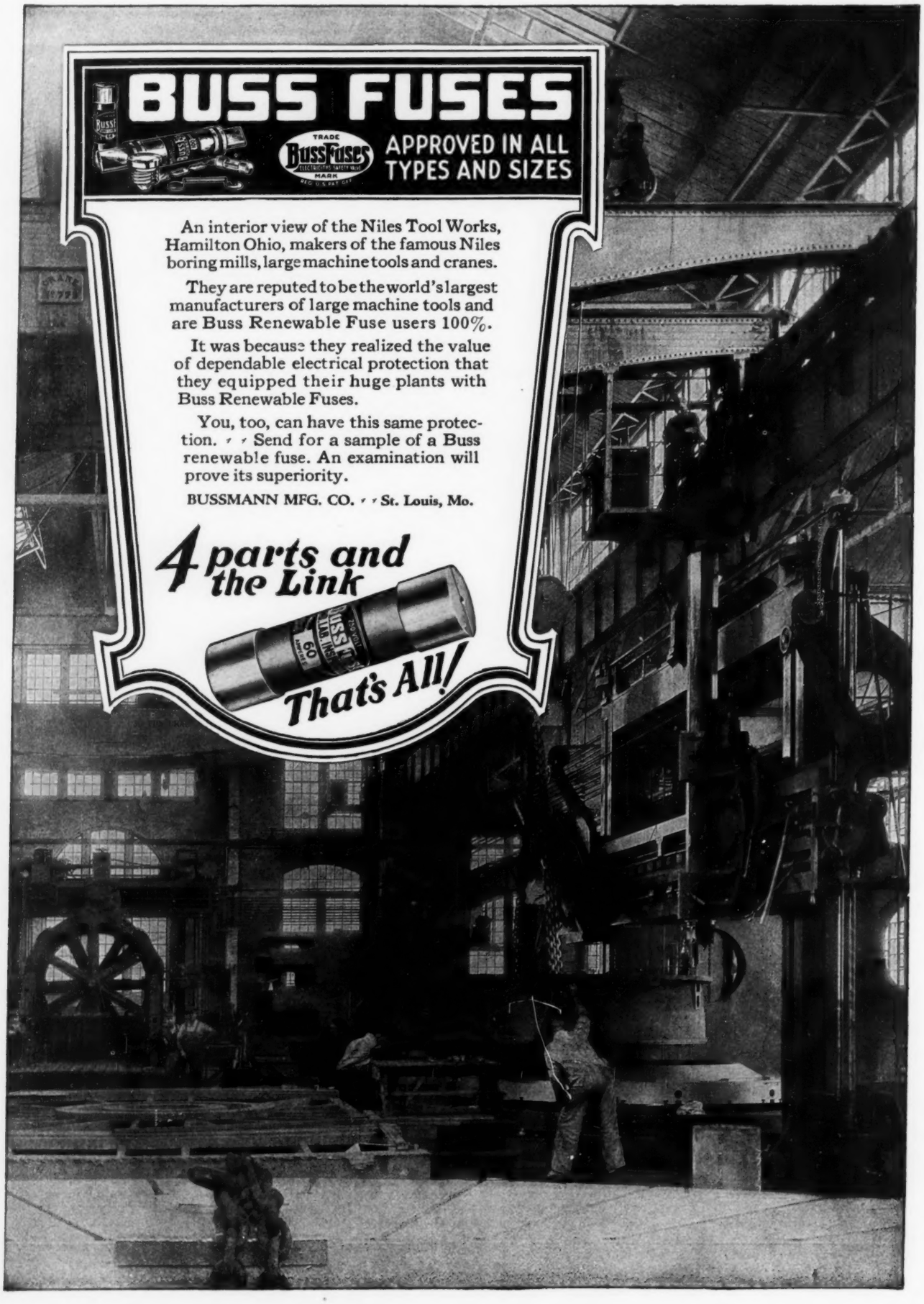
MANUFACTURER OF RAILWAY, POWER AND INDUSTRIAL ELECTRICAL MATERIAL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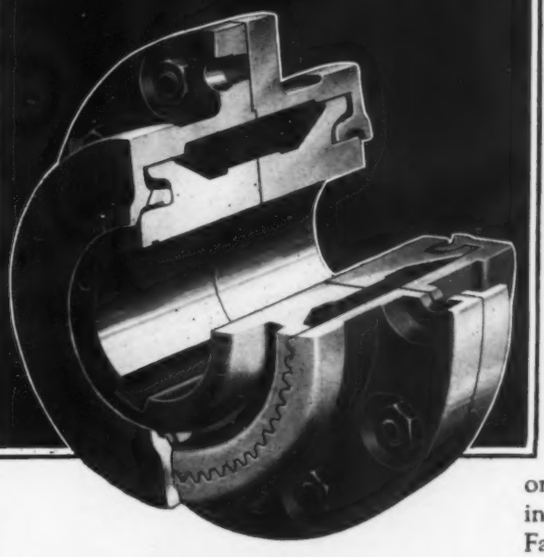
MARK
APPROVED IN ALL TYPES AND SIZES
An interior view of the Niles Tool Works, Hamilton Ohio, makers of the famous Niles boring mills, large machine tools and cranes.
They are reputed to be the world's largest manufacturers of large machine tools and are Buss Renewable Fuse users 100%.
It was because they realized the value of dependable electrical protection that they equipped their huge plants with Buss Renewable Fuses.
You, too, can have this same protection. Send for a sample of a Buss renewable fuse. An examination will prove its superiority.
BUSSMANN MFG. CO. St. Louis, Mo.
4 parts and the Link
That's All!

FAST'S FLEXIBLE COUPLING

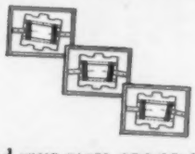
Contains No Flexible Materials to Fatigue and Fail Fast's Flexibility is Purely Mechanical

FAST'S solves the flexible coupling problem for life. Through elimination of flexible materials it eliminates fatigue and failure, and is therefore trouble-proof and permanent. It contains no rubber, leather, fibre, laminated steel pins, springs, grids or discs to wear out and need replacement. Instead, it is all-metal and its flexibility is obtained mechanically—there is no bending, stretching or twisting of any flexible material. Note exaggerated diagram of Fast's Principle.

Because no power is consumed in distorting any flexible materials, there are no side thrusts set up in the bearings of the connected machines and this adds years to the life of your equipment. Being a double-engagement coupling, it unfailingly compensates for all forms of shaft misalignment. It allows free lateral float and eliminates all whip and crank action.



FAST'S PRINCIPLE
of Mechanical Flexibility



Two generated spur gears, one on each shaft end, are continually and completely meshed in oil with the internal gears of a floating sleeve. The shafts and sleeve revolve as one unit, allowing the connecting sleeve free lateral and angular play.

To insure the long life and smooth operation of Fast's coupling, all wear of the load carrying surfaces is entirely eliminated through positive lubrication under centrifugal force. A permanent film of oil always carries the load when the coupling is in motion, thus the power transmitted is cushioned, and all metal-to-metal contact and wear eliminated.

In any class of service, on any job, large or small, high or low speed, heavy duty reversing drives — the result with a Fast's Flexible Coupling will always be the same: No fatigue, no failure — continuous operation! Once you install Fast's, you free your machinery from coupling troubles forever, no shutdowns, no replacements.

Fast's is a flexible coupling that *is different*, and is well worth your investigation. Write today for the new catalog.

THE BARTLETT HAYWARD COMPANY
SCOTT and McHENRY STREETS BALTIMORE, MARYLAND

FAST'S FLEXIBLE COUPLING

Heavy Duty Steel Mill Type, Fast's Flexible Coupling, Roughing and Finishing Plate Mill Drives, Reversing Service, 2500 H. P. at 25-80 R. P. M. Lukens Steel Company, Coatesville, Pa.

Write for this
NEW CATALOG
of a Flexible Coupling without Flexible Materials.

Mill Motor
COUPLING

FOR AUXILIARY STEEL MILL DRIVES, making it possible to change motors quickly on table rolls, conveyor drives, skew tables, and auxiliary drives. One hub of the coupling is made to fit the full length taper of the tapered shaft of an enclosed mill-type motor. Regular lock nut of the mill motor shaft is used, so that the coupling can be removed quickly and a new motor installed. The U. S. Standard bolts are neither shrouded nor countersunk, but are in the open, easily reached by an ordinary wrench. No special wrenches or tools required.

See Preceding Page

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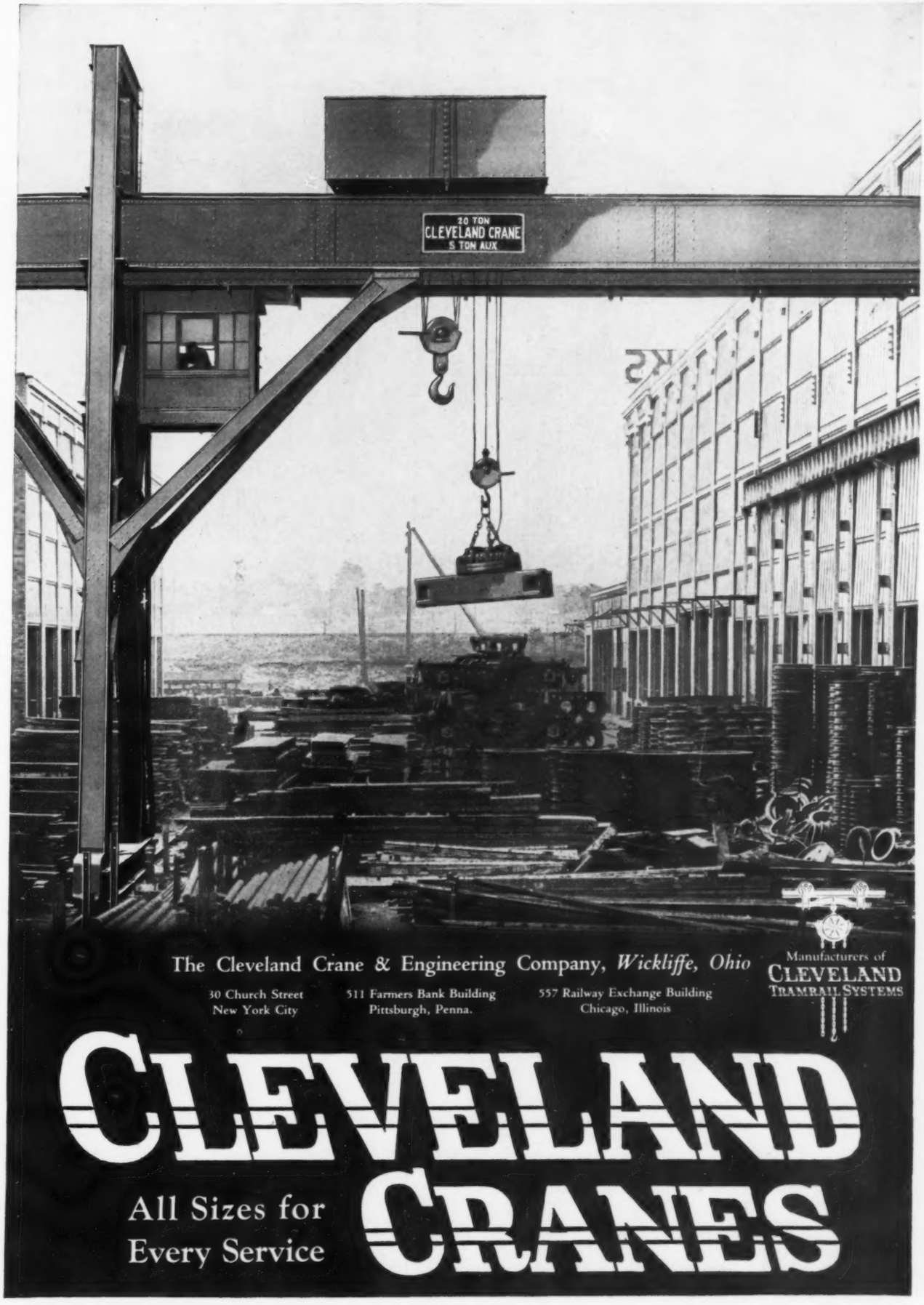
FAST'S FLEXIBLE COUPLING



The Cleveland Crane & Engineering Company, *Wickliffe, Ohio*

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Manufacturers of
CLEVELAND
TRAMRAIL SYSTEMS

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All Sizes for
Every Service

DEPENDABLE

Crocker-Wheeler Form "H" Motor—Direct Current
25 to 400 H. P.—115,230 and 550 Volts—Constant Speed and Adjustable Speed

THERE'S only one way to build a thoroughly dependable motor—*don't skimp.* Put plenty of copper in it—make the frame extra-rugged to stand heavy strains—provide large bearings—design each part as if solely on each part depended the service of the motor as a whole.

This is the way we build the Crocker-Wheeler Form "H" Motor.

We would welcome your inquiry and an opportunity to tell you more about Crocker-Wheeler Dependability and the economies it has effected. Crocker-Wheeler Motors and Generators are made in a wide variety of types and sizes for every purpose.

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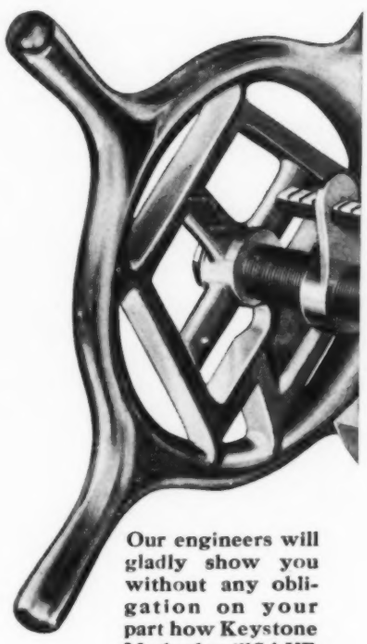
CROCKER-WHEELER

SAVES



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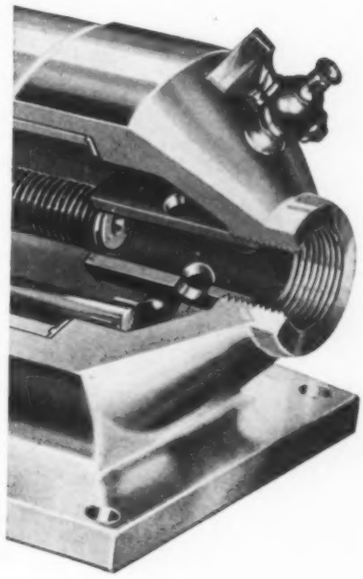
Ask any plant executive or engineer the chief cause of machinery failure, and he'll tell you, "Lack of lubrication"!—The surest way to combat it is by installing on your equipment the Keystone System of Grease Lubrication.

WORKMEN

It not only means positive lubrication of every part and bearing, but it's easy, convenient, and *safe.*—From one central point, the operator turns the wheel—there is no danger from moving machinery, no risk to life and limb.



..MONEY..

There is no loss of lubricant due to oil drip—no expensive and perhaps disastrous fires. Every pound of lubricant you pay for does its work when and where it should.

...TIME...

Valuable minutes are never lost by workmen hunting out each individual bearing—no time and profits are wasted by shut-downs for oiling—and repairs are reduced to a minimum.—"Efficiency's Working Mate". That's what the Keystone System is.

KEYSTONE
TRADE MARK
Reg. U.S. Pat. Off.
GREASE

Write us now for the whole story in your free copy of our 48-page book, "Questions Answered and Typical Installations Illustrated".—Second Edition.

KEYSTONE LUBRICATING COMPANY

21st & Clearfield & Lippincott Streets, Philadelphia

E S T A B L I S H E D 1 8 8 4

PRESSURE BURNERS
for
Blast Furnace Gas

Freyn-Design

Three motor-driven pressure burners installed at the blast furnace plant of the Central Alloy Steel Corporation at Canton, Ohio, have raised stove heats and improved the furnace economy.

Freyn-Design pressure burners are automatically controlled. They are simple but substantial.

FREYN ENGINEERING COMPANY

Consultants—Engineers—Contractors

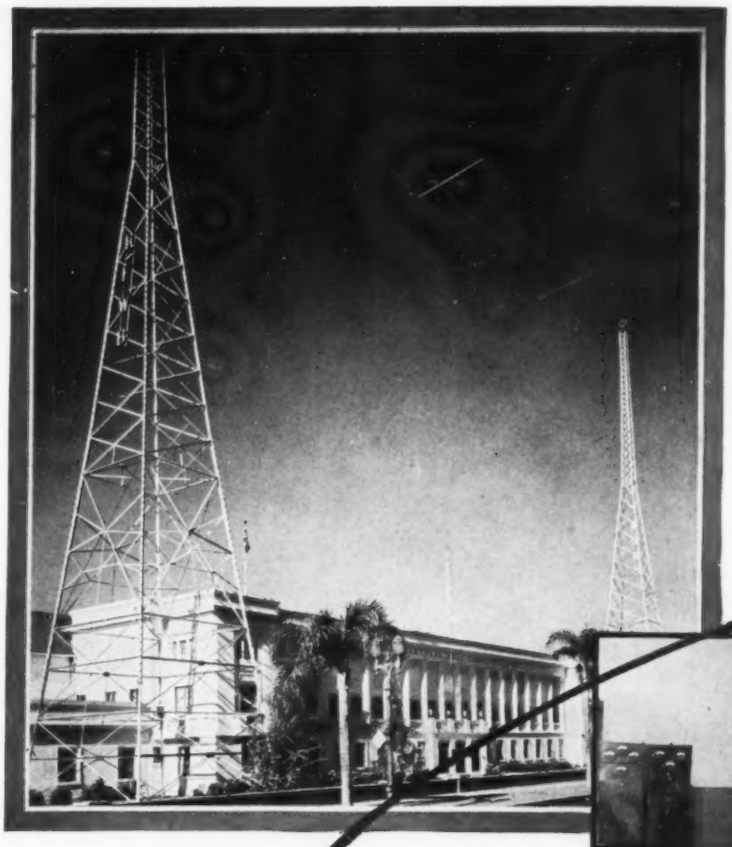
310 South Michigan Avenue

CHICAGO

1500 Chestnut Street
Philadelphia

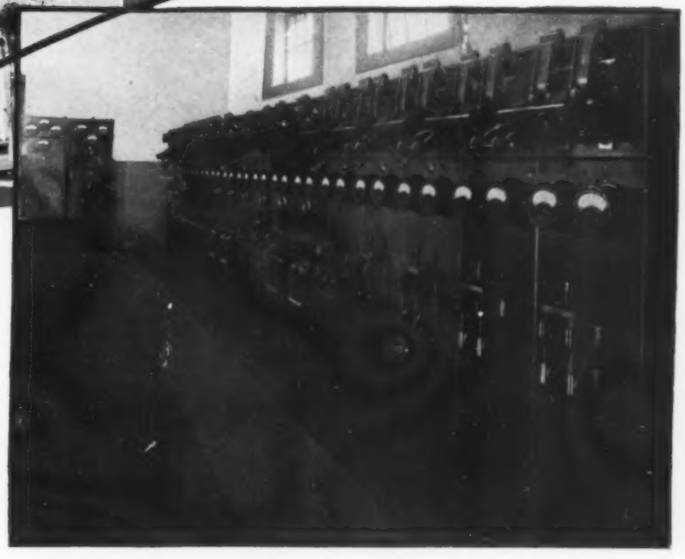
149 Broadway
New York, N. Y.

1501 Euclid Avenue
Cleveland, Ohio



ROLLER SMITH

Circuit Breakers and Instruments at the



Warner Brothers West Coast Studios Hollywood, Cal.

The Magnificent West Coast Studios of Warner Brothers, Hollywood, California, house a 20 panel switchboard which was designed, constructed and installed under the direction of Mr. F. N. Murphy, Chief Electrician for Warner Brothers.

The total output is over 12,000 amperes, but the overloads are frequent and tremendous. The installation has been operating for four years **with 100% satisfaction.**

There are fourteen ROLLER-SMITH circuit breakers ranging in capacity from 1000 amperes down.

There are thirty-seven ROLLER-SMITH Types SA and SD (7½ inch round) instruments.

"Over thirty years' experience is back of ROLLER-SMITH"

ROLLER-SMITH COMPANY

Electrical Measuring and Protective Apparatus

ROLLER SMITH

MAIN OFFICE
2131 Woolworth Bldg., NEW YORK

WORKS
Bethlehem, Pennsylvania

Offices in Principal Cities in the United States and Canada.

Representatives in Australia, Cuba and Japan.

Remove the Shackles

Excessive pitting of the commutator and sparking at the brushes is oftimes the outward sign of carbon brush trouble—the carbon is too hard, too soft, streaked with hard and soft spots causing uneven wear or has the wrong electrical characteristics.

It is these irregularities in inferior carbon brushes that shackle the efficiency of your motors.

Stackpole Brushes are the solution. The carbon and graphite going into every type of Stackpole Brush is scientifically compounded to meet a definite type of machine. This assures a smooth, velvet-like contact—a brush that wears slowly and evenly—a carbon brush that gives 100% efficiency at every turn of the commutator—a brush that you can depend on right down to the holder.

STACKPOLE CARBON COMPANY

St. Marys, Penna.

Stackpole carbon brushes

Get this interesting magazine

We will send it every month without charge

EVERY number is packed with power plant stories, useful power plant information, shop kinks, interesting new developments, a few laughs for the general good of the engineering soul, and other lively items.

One reader, Mr. J. P. McRae of the General Supply Company of Ottawa, Canada, says:

"Please accept the writer's best thanks for the copy of The Power Specialist which he read with very considerable interest.

"For those of us whose main occupation in life is trying to determine the most efficient use of the elusive B. t. u. such a periodical is of tremendous interest."

Let us send The Power Specialist to you. Simply fill out the coupon and send it in. We will see that you get it regularly every month without charge. Send in the coupon now.

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"LE CARBONE"
CARBON BRUSHES

Standard of Quality and Uniformity

They are supplied not alone to suit type of machine, but your operating conditions.

Guaranteed Without Argument

Real Engineering Service.

W. J. Jeandron, Hoboken Factory Terminal, Building F, Fifteenth St., Hoboken, N. J.

Pittsburgh Office, 634 Wabash Bldg.
A. M. RAMSEY, Sales Engineer

San Francisco Office, 525 Market St.
W. R. CATCHING, Sales Engineer

Chicago Office, 1657 Monadnock Block

Canadian Distributors: Lyman Tube & Supply Co., Ltd.
Montreal and Toronto

POSITIVE LUBRICATION

Hyatt Roller Bearing turning in a glass housing to show its ideal method of lubricant distribution.

THE helical construction of the right and left hand, alternately assembled, Hyatt rollers keeps the oil in constant motion. This insures cool running bearings and extends their life immeasurably.

Note the lubricant oozing out of the hollow rollers. As the bearing turns each roller leaves a trail of lubricant over every part of the operating surface — there's never a dry spot.

Hyatt housings are sealed against grit, dirt and other abrasive substances. There is practically no friction or wear. Repairs and replacements are rare. The bearings require no attention except an occasional lubrication.

Many of the best known equipment builders use Hyatts extensively because their advantages have been universally proved in the most difficult places.

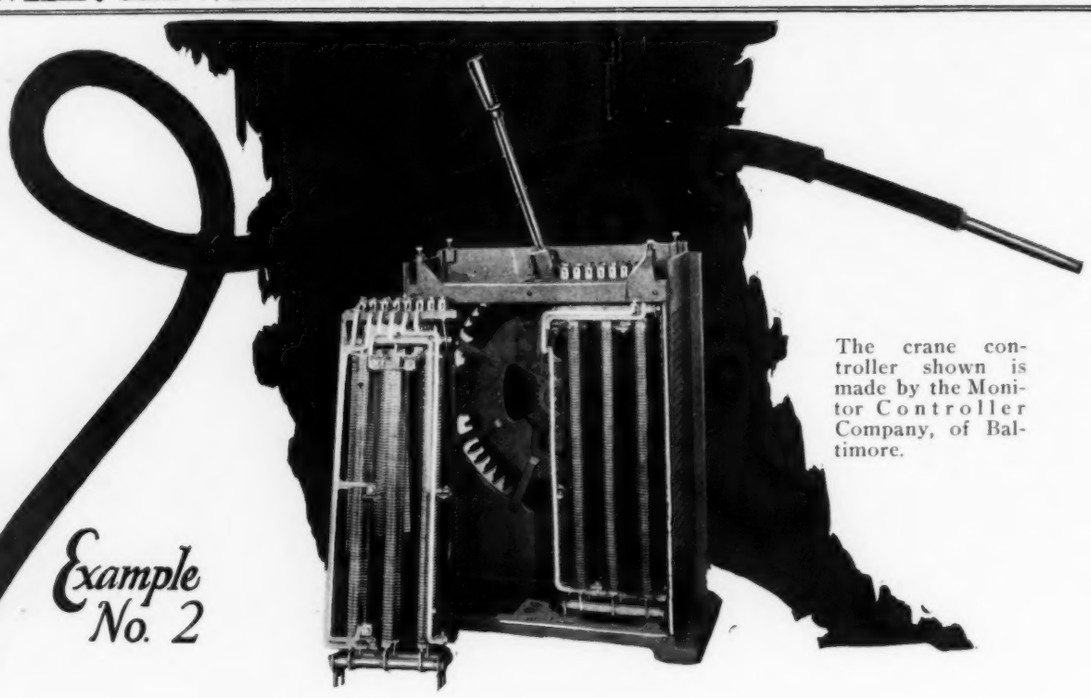
HYATT ROLLER BEARING COMPANY

Newark Detroit Chicago Pittsburgh
Worcester Philadelphia Oakland Cleveland

HYATT
ROLLER BEARINGS

PRODUCT OF GENERAL MOTORS

WHY WHEN and WHERE TO USE **ROCKBESTOS** —*the asbestos covered wire*



The crane controller shown is made by the Monitor Controller Company, of Baltimore.

Example No. 2

For Hot Controls in Hot Places

Rockbestos—the asbestos covered wire — is right in its native element under these conditions.

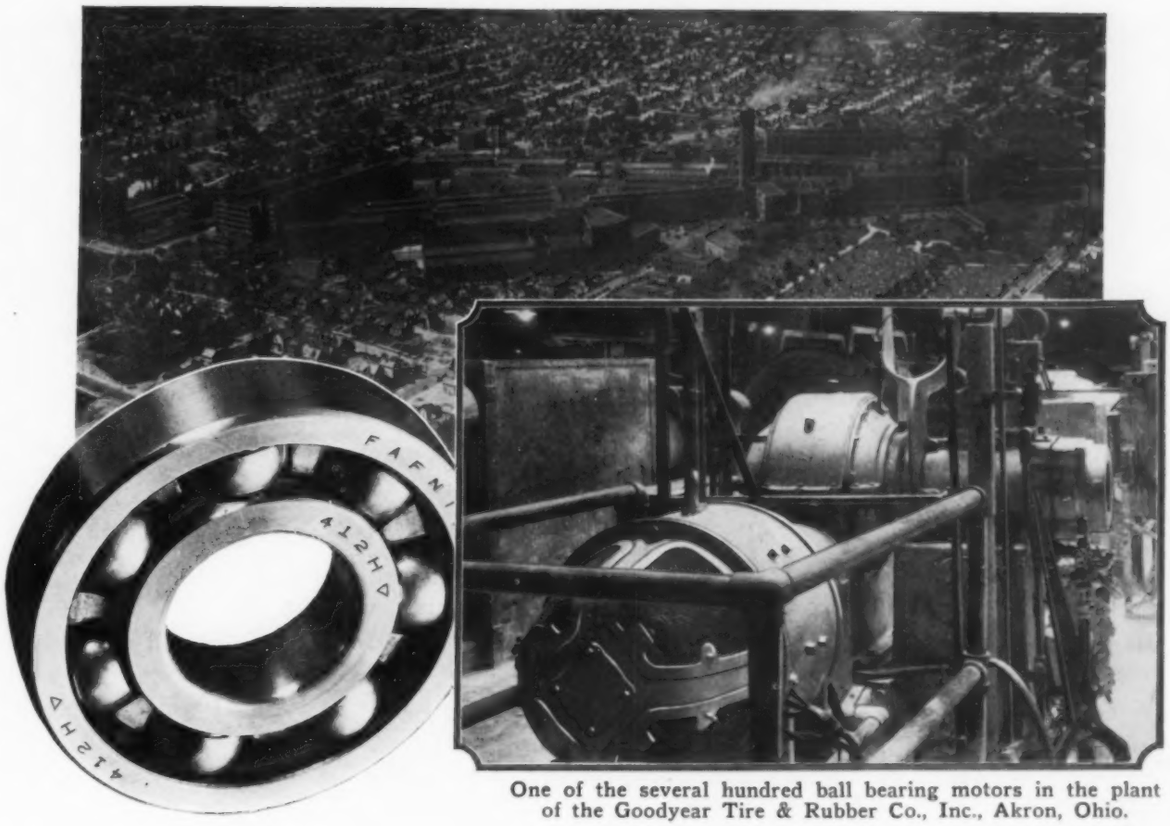
At a temperature that will melt copper, the insulation will still live.

The installation shows an application of Rockbestos to a crane motor controller. Rockbestos shows outstanding advantages on jobs like this.

In boiler rooms, foundries, over open hearths anywhere in the mills, where hot gases and fumes rise to the monitor, use Rockbestos, and enjoy freedom from high temperature troubles. Your wiring will be insured for long life.

ROCKBESTOS PRODUCTS
CORPORATION
NEW HAVEN, CONN.

5942 Grand Central Term. Bldg., New York. 465 Union Trust Bldg., Pittsburgh, Pa. 224 Madison Term. Bldg., Chicago
On the Pacific Coast—Allied Industries, Inc.



One of the several hundred ball bearing motors in the plant of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Goodyear endorses ball bearings

AN endorsement from Goodyear is an endorsement indeed!

Still, Goodyear's enthusiastic endorsement of ball bearings is deserved. Of the 100 **ball bearing** motors that were installed in 1918 —all have been running continuously ever since—night and day.

Yet no repairs have been needed.

As Mr. Philip C. Jones, Electrical Engineer of the Akron, Ohio, plant puts it: "—with grease-filled ball bearings, we find we eliminate a lot of trouble, as well as diminish our oiling expense."

THE FAFNIR BEARING COMPANY, NEW BRITAIN, CONN.

Makers of high-grade ball bearings—the most complete line of types and sizes in America

NEWARK CHICAGO CLEVELAND DETROIT

EUROPEAN AGENT

Benjamin Whittaker, Ltd., Aldwych House, London W.C.2, England

FAFNIR

BALL BEARINGS

Molybdenum Steel Throughout IN BOTH RINGS AND BALLS

Noark

There is no advantage in using cheap fuses to guard against destructive overloads. The cost of renewing even a simple circuit — to say nothing of the expense of rewinding the armature of a motor — is always far greater than anv difference in price of a fuse.

Look for the "Un. Lab. Inspected" label on every fuse you buy. It is your first insurance of a good fuse.

But if you would make assurance doubly sure and know beyond the shadow of a doubt that every sentinel you set to guard your electrical installations will not fail in point of alertness and dependability, see that the name

NOARK

too, is on everv fuse you buy.

Noark fuses, ferrule or knife blade types, renewable or non-renewable, indicating or non-indicating, all are made to

"Blow on the Dot"

and—when used according to their indicated capacities—it is physically impossible for them to fail to do their duty.

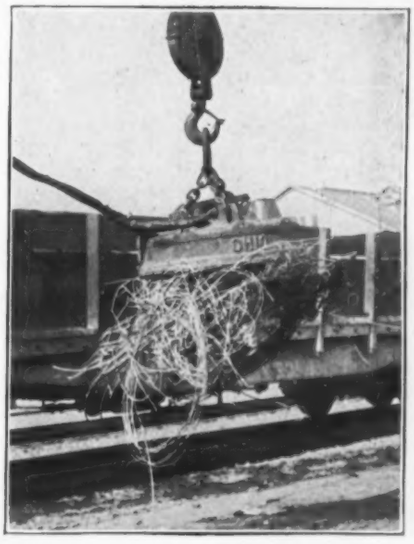
COLT'S PATENT FIRE ARMS MFG. CO.
Electrical Division
HARTFORD, CONN. U. S. A.
NEW YORK~BOSTON~CHICAGO~SAN FRANCISCO

33-F-10

These pictures show a 36" diameter Ohio Magnet handling a variety of materials from wire to steel rails easily and no complaint if worked 365 days of 24 hours per day.

The magnet automatically rejects any copper, brass or babbitt which can then be collected and sold at appropriate prices.

Ohio Magnet Outer Rings are solid, they very seldom break. All insulation is asbestos. Upkeep cost is very low.



Have you a Magnet Problem?

OHIO reliable MAGNETS

The
Ohio Electric & Controller Co.
5903 Maurice Avenue
Cleveland, Ohio

SAFETY
V·V
SWITCHES

QUICK POSITIVE MAKE
QUICK WIDE BREAK

30-60
100-200-400
Ampere

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V.V.
Sturdy
Construction

250-500
600
Volts.

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Mechanical
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Cast Iron—Type WBG—Weatherproof

WITH THE USUAL V. V. SAFETY FEATURES

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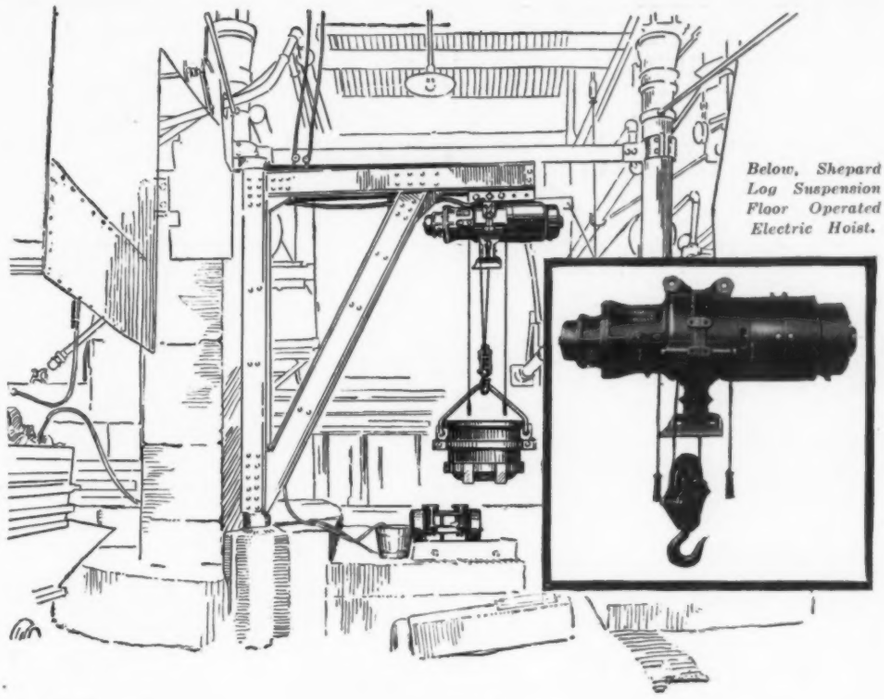
CONDUIT
V·V
FITTINGS



Below, Shepard Log Suspension Floor Operated Electric Hoist.

"Uninterrupted service—30 tons of molten lead daily"

Such is the service of the floor operated Shepard Hoist at the American Smelting and Refining Co., Leadville. Col.

Exposed daily to direct radiation from 30 tons of molten lead to fumes and dust, the hoist has given "uninterrupted service."

Not alone does Shepard give you enclosed unit construction, balanced drive and automatic oil bath lubrication. Shepard provides a precision control that means absolute safety in handling dangerous loads and delicate lifts.

Shepard renders a complete "uninterrupted service" to industry, by building a comprehensive, performance-proved line of electric hoists and cranes—a load handling service that is adaptable to the specific requirements of any industry.

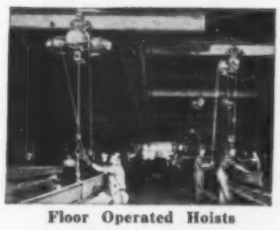
SHEPARD ELECTRIC CRANE & HOIST CO.
376 Schuyler Ave., Montour Falls, N. Y.

SHEPARD
ELECTRIC CRANES & HOISTS

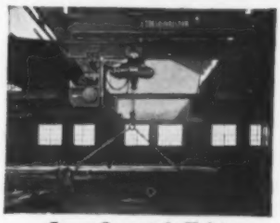
Largest Manufacturer of Electric Hoists in America

Branch offices are maintained in principal cities

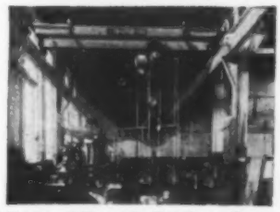
Shepard Serves Industry with



Floor Operated Hoists



Cage Operated Hoists



I-Beam, Jib and Bracket Cranes

Transfer Cranes

Traveling Cranes

Shepard Tracks and Switches

Winches

100 TON OPEN HEARTH FURNACE

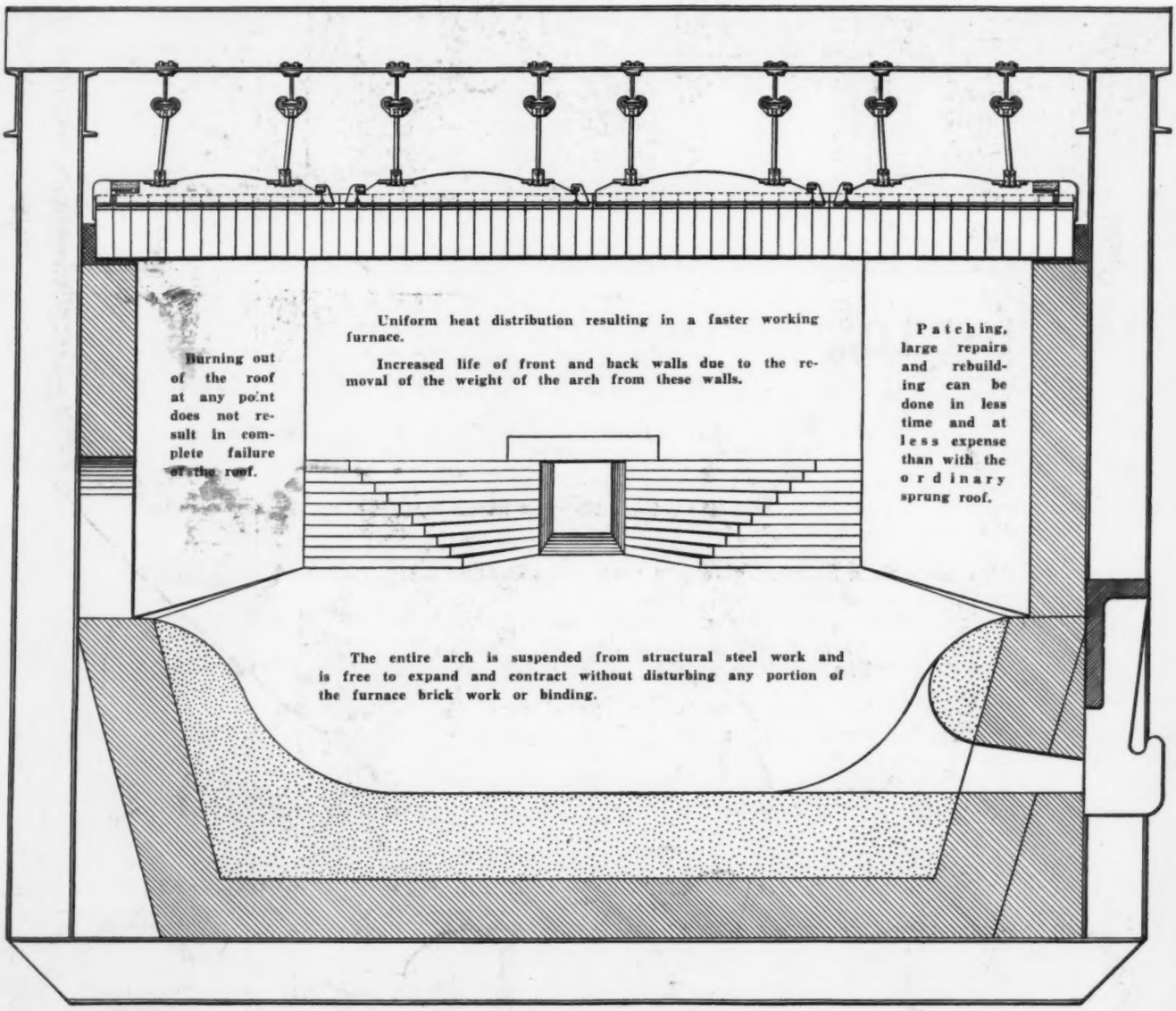
at

DONNER STEEL COMPANY

uses

DETRICK FLAT SUSPENDED ROOF

The Detrick Flat Suspended Roof in connection with the 100 Ton Open Hearth Furnace at the Donner Steel Company, Buffalo, New York, is shown below. This roof has now been in operation for a sufficient length of time to prove its merits. Donner Steel Company has put its stamp of approval on the Flat Suspended Roof.


Burning out of the roof at any point does not result in complete failure of the roof.
Uniform heat distribution resulting in a faster working furnace.
Increased life of front and back walls due to the removal of the weight of the arch from these walls.
Patching, large repairs and rebuilding can be done in less time and at less expense than with the ordinary sprung roof.
The entire arch is suspended from structural steel work and is free to expand and contract without disturbing any portion of the furnace brick work or binding.

For further information regarding the Detrick Flat Suspended Open Hearth Roof to suit your particular requirements, write to:

M. H. DETRICK COMPANY—140 South Dearborn Street, Chicago, Ill.

Pittsburgh: Empire Building **New York: 50 Church Street**

BRANCHES IN PRINCIPAL CITIES.